FINAL
FEASIBILITY STUDY
CHEROKEE COUNTY OPERABLE UNIT 8 RAILROADS SITE
CHEROKEE COUNTY, KANSAS

Prepared for:

U.S. Environmental Protection Agency Region 7
11201 Renner Boulevard
Lenexa, KS 66219

Architect and Engineering Services Contract EP-S7-05-05
Task Order: 0061

July 2016

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CHEROKEE COUNTY, KANSAS

Prepared for:

U.S. Environmental Protection Agency Region 7
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July 2016

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LIST OF ACRONYMS AND ABBREVIATIONS

AES	Architect and Engineering Services
ALM	adult lead methodology
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	below ground surface
CCR	Cherokee County Site-Operable Unit 8 Railroads
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	contaminant of concern
COPC	contaminant of potential concern
CSM	conceptual site model
CY	cubic yards
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
FRTR	Federal Remediation Technologies Roundtable
FS	Feasibility Study
GRA	general response action
HGL	HydroGeoLogic, Inc.
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
IC	institutional controls
IEUBK	Integrated Exposure Uptake Biokinetic
μg/dL	micrograms per deciliter
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
O&M	operation and maintenance
OMB	Office of Management and Budget
OU	operable unit
PRG	preliminary remediation goal
RA	remedial action
RAO	remedial action objective
RI	Remedial Investigation
ROD	Record of Decision
RSL	regional screening level

TAL	target analyte list
TRV	toxicity reference value
U.S.C.	United States Code
XRF	x-ray fluorescence

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EXECUTIVE SUMMARY

HydroGeoLogic, Inc. (HGL) is conducting a Remedial Investigation (RI)/Feasibility Study (FS) at the Cherokee County Site - Operable Unit (OU)8 Railroads (CCR) site in Cherokee County, Kansas. This work is being completed under the Region 7 U.S. Environmental Protection Agency (EPA) Architect and Engineering Services (AES) contract EP-S7-05-05, Task Order 0061.

This FS was developed to be consistent with EPA guidance for conducting an FS under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The cost estimates for each alternative were developed in accordance with the EPA guidance document *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA, 2000). This FS contains the detailed evaluation of remedial alternatives addressing the human health and environmental risks and concerns at OU8 and was developed to assist the EPA to propose and take public comment on a preferred remedy that addresses contaminated soil at OU8.

Site Location, History, and Contamination

The Cherokee County Superfund Site spans 115 square miles and represents the Kansas portion of the Tri-State mining district. The Tri-State Mining District covers approximately 2,500 square miles in northeast Oklahoma, southwest Missouri and southeast Kansas and was one of the foremost lead-zinc mining areas of the world. The district provided nearly continuous production from about 1850 until 1970, during which it produced an estimated 500 million tons of ore, with about 115 million tons produced from the Kansas portion of the district.

The Cherokee County Superfund Site consists of mine tailings, soil, sediment, surface water, and groundwater contaminated with heavy metals (principally lead, zinc, and cadmium). The primary sources of contamination are the residual metals in the abandoned mine workings, chat piles, and tailings impoundments in addition to historical impacts from smelting operations. The Site was placed on the National Priorities List in 1983. As listed, the Cherokee County Superfund Site encompasses 115 square miles including the following seven subsites: Galena, Baxter Springs, Treece, Badger, Lawton, Waco, and Crestline. These seven subsites encompass most of the area where mining occurred within the Site and where physical surface disturbances were evident. These subsites have been divided or grouped into the following OUs:

- OU1 - Galena Alternate Water Supply;
- OU2 - Spring River Basin;
- OU3 - Baxter Springs subsite;
- OU4 - Treece subsite;
- OU5 - Galena Groundwater/Surface Water;
- OU6 - Badger, Lawton, Waco, and Crestline subsites; and
- OU7 - Galena Residential Soils;
- OU8 – Railroads; and
- OU9 – Tar Creek Watershed.

During the years the mines operated, railroads were constructed in Cherokee County to join conventional large-scale railroads to the individual mining operations. The ballast material used in the railroad beds was composed of chat from surrounding mine waste piles. Traditionally, these

historical railroads were abandoned in place when mining operations ceased at that mine. Currently, the historical rail lines that cross through private property vary in condition: some show little deterioration from their original condition; others have degraded to the point they are unidentifiable as former rail lines. Depending on the current use of the area, some former rail lines exhibit extensive vegetative regrowth with a thick organic layer, while others have been incorporated into the surrounding area. Some historical rail lines have been investigated and remediated within other OUs. At some locations, some of the ballast may have been completely removed in areas along the rail lines as a result of construction activities, such as highway cuts. OU8 comprises the portions of the rail lines within the Cherokee County Superfund Site that have not been or will not be addressed in the remediation of other OUs and that have not been addressed by other means.

During the RI phase of this project, a human health risk assessment (HHRA) and a streamlined ecological risk assessment (ERA) was prepared for OU8 to determine whether contaminant exposure posed unacceptable risks to residents and wildlife. No significant human health risks were identified in the HHRA. The ERA results indicate that site-related contaminants in surface soil, surface water, and sediment may pose a threat to ecological receptors. However, sediment contamination does not appear to be attributable to the rail line. This FS addresses soil contamination only.

Remedial Action Objectives

Based on the results of the risk assessments, lead and zinc were identified as contaminants of concern (COCs) posing risk to ecological receptors. To address these risks, the remedial action objectives (RAO)s identified for CCR OU8 for protection of ecological receptors are:

- Prevent exposure of ecological receptors to COCs in source materials that would potentially result in unacceptable ecological risks.
- Prevent exposure of ecological receptors to COCs in soils that would potentially result in unacceptable ecological risks.

Cleanup Levels

Ecological cleanup levels for soil were established as part of the ERA (EPA, 2015) and, at EPA's directive, are being used in this FS to determine the volume of materials requiring remediation. Preliminary cleanup levels for site COCs in soil are presented in Table ES.1.

Table ES.1
Preliminary Cleanup Levels for Soil COCs

COCs	Cleanup Level Soil (mg/kg)
Lead	1,770
Zinc	4,000

mg/kg = milligrams per kilogram

Remedial Alternatives

Alternative 1 – No Action

Alternative 1 is required by the National Contingency Plan (NCP) to provide an environmental baseline against which impacts of the various remedial alternatives can be compared. The only actions that would be implemented for Alternative 1 are completion of Five-Year Reviews as required by the NCP. There would be no change in the soil contaminant concentrations because no treatment, containment, or removal of source materials or contaminated soil is included in this alternative. Therefore, potential ecological risks due to exposure to contaminated materials would remain.

Alternative 2 – Source Removal, On-Site Consolidation and Capping

Alternative 2 provides protection of ecological receptors through remedial action (RA) involving excavation and removal to limit exposure to and mobility of contaminants. Under this alternative, all ballast and contaminated soil with concentrations of lead and/or zinc that exceed the preliminary cleanup levels would be excavated and then consolidated and capped in small containment areas along the former rail beds. Excavated areas, assuming that some amount of soil below the footprint of the former railroad spurs requires removal, would be backfilled with clean fill and topsoil and the areas graded to provide positive drainage. Vegetative cover would be established over the backfilled area to restore the property and to provide vegetative root systems to hold the soil in place, preventing erosion and off-site transport by surface runoff or wind. Erosion and sediment controls will be maintained for 1 year while the vegetative cover is being established.

Excavated soil would be placed in consolidation areas at each work site or within a cluster of closely spaced small sites. A bulldozer or other grading equipment would be used to grade the mine waste in the consolidation areas. The mine waste consolidation areas would be covered with a multi-layer cap to prevent future contact with and erosion of the mine waste. The cap would consist of 12 inches of locally available clayey soil and 6 inches of topsoil. This type of cap configuration has been successfully implemented at similar OUs addressed as part of the previous Baxter Springs, Treece, Waco, and Lawton mine waste remedies. The consolidation areas would be graded to provide positive drainage. Operation and maintenance (O&M) will be required to retain the integrity of the cap.

Alternative 3 – Source Removal, Waste Consolidation and Capping at OU3/OU4 Consolidation Areas

Alternative 3 provides protection of ecological receptors through RA involving excavation and removal to limit exposure to and mobility of contaminants. As in Alternative 2, all ballast and contaminated soil with concentrations of lead and/or zinc that exceed the preliminary cleanup levels would be excavated, the remediated areas backfilled with clean fill and topsoil, and graded to provide positive drainage. Vegetative cover would be established over the backfilled area to restore the property and to provide vegetative root systems to hold the soil in place, preventing erosion and off-site transport by surface runoff or wind. Erosion and sediment controls will be maintained for 1 year while the vegetative cover is being established.

Excavated soil would be loaded into haul trucks and transported to a central consolidation area, dumped, graded, and capped as described above under Alternative 2. For the purpose of estimating costs and level of effort, it is assumed that one of the proposed waste consolidation areas to be constructed as part of the OU4 Phase 3 Baxter/Treece RAs would have adequate capacity to receive these materials, would be located within a 20-mile radius of each removal area, and would actively be undergoing construction at the same time as the OU8 removal activities.

Alternative 4 – On-Site Capping

Alternative 4 requires no excavation of materials but provides protection of ecological receptors by capping the contaminated materials in place with 12 inches of locally available clayey soil and 6 inches of topsoil and establishing vegetation on the cap. O&M will be required to retain the integrity of the cap.

Analysis of Remedial Alternatives

A detailed evaluation of the remedial alternatives was performed using seven of the nine EPA evaluation criteria and is summarized in Table ES.2.

- Protection of Human Health and the Environment
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)
- Long-Term Effectiveness and Performance
- Reduction of Toxicity, Mobility, or Volume
- Short-Term Effectiveness
- Implementability
- Cost

State and community acceptance criteria are the final two EPA evaluation criteria and cannot be adequately addressed until after the FS Report is released for regulatory and public review. These criteria will be assessed in the Record of Decision responsiveness summary.

Table ES.2
Summary of Comparative Analysis of Alternatives for the Cherokee County OU8 Railroads Site

Remedial Alternative	Description	Threshold Criteria		Balancing Criteria				
		Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short-Term Effectiveness	Implementability	Present Value Cost (Dollars)
1	No Action	—	—	⓿	⓿	⓿	❺	$103,000
2	Source Removal, On-Site Waste Consolidation and Capping	+	+	❸	❶	❸	❸	$14,965.000
3	Source Removal, Waste Consolidation and Capping at OU3/OU4 Consolidation Areas	+	+	❹	❶	❷	❹	$16,028,000
4	On-Site Capping	+	+	❸	❶	❸	❸	$10,450,000

Notes:
1. The numerical designations for the qualitative ratings system used in this table are not used to quantitatively assess remedial alternatives (for instance, individual rankings for an alternative are not additive).

Legend for Qualitative Ratings System:

Threshold Criteria

— **Unacceptable**

\+ **Acceptable**

Balancing Criteria (Excluding Cost)

⓿ **None**

❶ **Low**

❷ **Low to Moderate**

❸ **Moderate**

❹ **Moderate to High**

❺ **High**

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1.0 INTRODUCTION AND PURPOSE

HydroGeoLogic, Inc. (HGL) is conducting a Remedial Investigation (RI)/Feasibility Study (FS) at the Cherokee County Site - Operable Unit (OU)8 Railroads (CCR) site in Cherokee County, Kansas. This work is being completed under the Region 7 U.S. Environmental Protection Agency (EPA) Architect and Engineering Services (AES) contract EP-S7-05-05, Task Order 0061.

The FS was developed to be consistent with EPA guidance for conducting an FS under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (EPA, 1988). In addition, the cost estimates for each alternative were developed in accordance with *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA, 2000). This FS report addresses contaminated chat (source material) in OU8, which was used as ballast material for rail beds and underlying soil contaminated with heavy metals. This FS report contains a detailed evaluation of remedial alternatives addressing the environmental risks and concerns at OU8. It was developed to assist the EPA to propose and take public comment on a preferred remedy that addresses the source material and contaminated soil at OU8. This report is organized as follows:

Section 1 discusses the purpose of the FS report, and the report organization.

Section 2 describes the background and characteristics of the site, including site features and physical characteristics, a summary of the nature and extent of contamination, and a summary of the risk assessment.

Section 3 describes the process for identifying preliminary remedial action (RA) objectives (RAOs) and cleanup levels. This section also identifies potential applicable or relevant and appropriate requirements (ARARs) for the Site.

Section 4 describes the options for general response actions (GRAs) and the screening and evaluation of applicable remedial technologies and process options.

Section 5 describes the remedial alternatives and the screening process followed to reduce the remedial alternatives to those considered to be most suitable for possible implementation.

Section 6 describes the criteria used to evaluate the alternatives retained during the screening process completed in Section 5.0.

Section 7 presents a detailed analysis of the retained remedial alternatives and summarizes the comparative analysis conducted to compare and contrast the remedial alternatives.

Section 8 lists the references and documents referred to in this FS.

Appendix A provides a summary of Federal and State ARARs.

Appendix B documents the preliminary screening of alternatives.

Appendix C provides the detailed analysis of alternatives.

Appendix D provides the estimation of volumes of waste requiring remediation and backfill.

Appendix E provides the detailed alternative analysis cost information. Detailed analysis cost estimates have an expected accuracy range between +50 percent and -30 percent of the actual costs.

2.0 SITE BACKGROUND

2.1 SITE LOCATION AND DESCRIPTION

The Cherokee County Superfund Site spans 115 square miles and represents the Kansas portion of the Tri-State mining district (Figure 2.1). The Tri-State Mining District covers approximately 2,500 square miles in northeast Oklahoma, southwest Missouri and southeast Kansas and was one of the foremost lead-zinc mining areas of the world. The district provided nearly continuous production from about 1850 until 1970, during which it produced an estimated 500 million tons of ore, with about 115 million tons produced from the Kansas portion of the district.

The Tri-State Mining District is characterized by a variety of mine waste features that exhibit sparse to no vegetation. Local stream systems also contain mining wastes and mining-impacted sediments and surface water. Residential areas are adjacent to mine waste accumulations in some areas or have suffered historic impacts as a result of smelting. Lead and zinc are found in mining wastes and soils at maximum concentrations of several thousand milligrams per kilogram (mg/kg), while cadmium is typically found at levels less than 500 mg/kg.

EPA has listed four mining-related Superfund Sites in the Tri-State Mining District: the Tar Creek Site in Oklahoma; the Jasper County and Newton County sites in Missouri; and the Cherokee County Site in Kansas.

The Cherokee County Site consists of mine tailings, soil, sediment, surface water, and groundwater contaminated with heavy metals (principally lead, zinc, and cadmium). The primary sources of contamination are the residual metals in the abandoned mine workings, chat piles, and tailings impoundments in addition to historical impacts from smelting operations. The Site was placed on the National Priorities List in 1983. As listed, the Cherokee County Site encompasses 115 square miles including the following seven subsites: Galena, Baxter Springs, Treece, Badger, Lawton, Waco, and Crestline. These seven subsites encompass most of the area where mining occurred within the Site and where physical surface disturbances were evident. These subsites have been divided or grouped into the following OUs:

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- OU7 - Galena Residential Soils;
- OU8 – Railroads; and
- OU9 – Tar Creek Watershed.

During the years the mines operated, railroads were constructed in Cherokee County to join conventional large-scale railroads to the individual mining operations. Figure 2.2 illustrates the

current and former rail line locations through the County. The ballast material used in the railroad beds was composed of chat from surrounding mine waste piles. Traditionally, these historical railroads were abandoned in place when mining operations ceased at that mine. Currently, the historical rail lines that cross through private property vary in condition: some show little deterioration from their original condition; others have degraded to the point they are unidentifiable as former rail lines. Depending on the current use of the area, some former rail lines exhibit extensive vegetative regrowth with a thick organic layer, while others have been incorporated into the surrounding area. Some historical rail lines have been investigated and remediated within other OUs. At some locations, some of the ballast may have been completely removed in areas along the rail lines as a result of construction activities, such as highway cuts. OU8 comprises the portions of the rail lines within the Cherokee County Superfund Site that have not been or will not be addressed in the remediation of other OUs and that have not been addressed by other means.

Recently, many rail lines were abandoned by railroad companies and reverted back to the property owner through the Surface Transportation Board. Regional plans exist to convert some historic rail beds to the national Rails to Trails program. This conversion program has begun in the Missouri part of the region with potential expansion into Kansas. This potential change in land use affects the exposure scenarios evaluated in the human health risk assessment (HHRA) and in the ecological risk assessment (ERA).

Numerous remedial and removal actions have taken place throughout the Site as noted in RODs and Five-Year Reviews for the various OUs. Only those segments of the rail beds that run through other OUs or subsites at the Cherokee County Site have been investigated and remediated. The RI/FS of OU8 is the first investigation of rail lines that are not associated with investigations at areas identified as mining sites and characterized as part of another OU.

2.2 REGIONAL TOPOGRAPHY AND SURFACE DRAINAGE

The topography in southeast Kansas is generally gently sloping, except in the river valleys and areas of waste stockpiles and collapsed mine areas (Figure 2.1). Topographic relief in the stockpile areas within the Cherokee County Site approaches over 50 feet. Topographic relief associated with existing mine shafts and collapse features is on the order of 50 to 100 feet. Side slopes along the collapse features are generally very steep. The site topography along the rail road lines follows the regional topography.

The area generally east of the Spring River is in the Springfield Plateau section of the Ozark Plateaus province and is typical of the hilly timbered land in the Missouri Ozarks. Local relief between hilltops and stream valleys is as much as 200 feet in this area.

The county is drained by the Neosho and Spring rivers and their tributaries. Lightning, Cherry, and Fly creeks are the principal tributaries of the Neosho River in Cherokee County. Cow Creek, Shawnee Creek, Shoal Creek, and Brush Creek are the principal tributaries of the Spring River.

2.3 NATURE AND EXTENT OF CONTAMINATION

The RI Report summarizes the nature and extent of target analyte list (TAL) metals contamination in the rail beds in OU8 (HGL, 2016). The primary source of contamination for CCR OU8 is the chat used to construct the rail bed ballasts. The chat originated from mining activities and ore refinement processes that created chat, tailings, and other mine waste material that was transported to CCR OU8.

As a part of the RI, 102 test pits were excavated with a backhoe across the rail ballasts at 34 locations selected to represent varying rail bed conditions, classification, and geographical locations across CCR OU8. The locations are shown in Figure 2.2. At each test pit location, grab samples were collected at 6-inch intervals from the surface to a depth of 4 feet (48 inches) below ground surface (bgs) and screened with x-ray fluorescence (XRF). Depending on the location, one to five test pits were excavated and sampled.

Analytical results and visual observations were used to determine if there was consistency in the depth of the chat layer and if contamination had migrated into the native soil. Rail lines traversed both rural and residential areas.

2.3.1 Chemicals of Potential Concern

All soils contain trace amounts of metals that are naturally occurring in the Earth's crust. The chemicals of potential concern (COPC) metals for CCR OU8 and the matrices in which they occur are listed in Table 2.1 below.

Table 2.1
Preliminary Chemicals of Potential Concern

Preliminary COPC	Matrix	
	Surface Soil	Subsurface Soil
Cadmium	X	X
Lead	X	X
Zinc	X	X

The COPC metals listed above have been detected above the regional screening levels (RSLs) and have formerly been associated with mining-related activities in Cherokee County. However, all of the COPC metals are elements that are present in the earth's crust and, therefore, are naturally present in air, soil, and groundwater. Discussion of metals concentrations relative to typical background concentrations, screening values, and the physical and chemical characteristics of these metals, along with typical industrial uses and general pathways into the environment, are presented in detail in the RI Report (HGL, 2016). These metals were evaluated in the final HHRA and streamlined ERA performed by EPA and included in the RI Report (HGL, 2016). Results of the final HHRA and ERA evaluations are summarized in Section 2.5.

2.3.2 Summary of Soil Data

During the RI activities, soil samples were collected at 6-inch intervals from the ground surface to 48 inches bgs, yielding 101 surface soil samples (0 to 6 inches bgs) and 486 subsurface soil samples (6 to 48 inches bgs). In all 101 surface soil samples the surficial materials consisted primarily of weathered chat and not native soil. In the 486 subsurface soil samples, material consisted of weathered chat to a depth of about 30 inches where the material generally transitioned to native soil. Table 2.2 summarizes the RI data.

Table 2.2
XRF Screening Data from RI

Depth Interval (bgs)	Residential Soil RSL	Detection Range		Number of Samples	Number of Detections	RSL Exceedances
		Minimum	Maximum			
Cadmium						
0-6 inches	7.1	14	66	101	67	67
6-12 inches		14	74	81	62	62
12-18 inches		14	72	71	54	54
18-24 inches		14	74	68	47	47
24-30 inches		14	79	68	28	28
30-36 inches		18	36	68	25	25
36-42 inches		15	49	65	12	12
42-48 inches		13	37	65	10	10
Lead						
0-6 inches	400	13	2,271	101	99	44
6-12 inches		14	2,255	81	80	43
12-18 inches		22	2,218	71	70	37
18-24 inches		17	3,490	68	65	32
24-30 inches		10	16,533	68	59	16
30-36 inches		11	7,739	68	55	15
36-42 inches		12	2,720	65	49	6
42-48 inches		7	2,013	65	41	3
Zinc						
0-6 inches	2,300	55	20,467	101	101	71
6-12 inches		71	23,967	81	81	62
12-18 inches		81	30,050	71	71	53
18-24 inches		29	19,433	68	68	45
24-30 inches		18	22,603	68	68	23
30-36 inches		27	19,100	68	68	20
36-42 inches		20	7,429	65	65	8
42-48 inches		18	7,720	65	61	5

RSL = regional screening level

It should be noted that the cadmium detection limit for the XRF exceeded the Residential Soil RSL (HQ = 0.1) in all soil samples reported as nondetect for the metal.

The highest XRF readings observed are as follows:

- Cadmium
  - Surface soil – 66 at Location 5.
  - Subsurface soil – 79 at Location 27 (24 to 30 inches bgs).
- Lead
  - Surface soil – 2,271 at Location 9.
  - Subsurface soil – 16,533 at Location 13 (24 to 30 inches bgs).
- Zinc
  - Surface soil - 20,467 at Location 29.
  - Subsurface soil – 30,050 at Location 17 (12 to 18 inches bgs).

As shown in the RI data, COPC contamination was found to be widespread in both the surface and subsurface rail bed materials and no hotspots were indicated from the data. Metals concentrations generally decreased in the samples of native soil collected beneath the chat if it was encountered above the target depth of 48 inches. Ten samples collected from the deepest sample interval (42 to 48 inches) contained one or more of the three metals above their respective Residential Soil RSL. Chat was found to extend to the target depth of 48 inches at 7 locations shown on Figure 2.2: Locations 7, 8, 13, 21, 22, and 29.

2.4 FATE AND TRANSPORT

The Conceptual Site Model (CSM) is key to assessing the potential remedies that may be suitable for a site contaminated with organic or inorganic (metals) compounds. Characterization of the nature of the release and migration mechanisms, the extent of contamination, as well as an exposure pathway analysis, are required to determine the level of risk posed by the contaminant release and to select and to design an appropriate remedy. The physical and chemical characteristics of the COPCs are also taken into account when developing the CSM.

Based on historical background information and analytical results from previous field efforts, initial data considered in developing the CSM included:

- Chat from mining activities conducted in Cherokee County from 1850 to 1970 was used as ballast on rail road beds in the county;
- Selected metals contamination was detected in the surface and subsurface soil fill material (chat) used as ballast for the rail beds;
- Native soil also was contaminated with metals to a depth of 48 inches bgs, likely due to leaching of metals from the overlying weathered chat ballast;
- Surface soils on and near the rail beds also may have been impacted by surface water runoff and airborne dust from mine wastes lying adjacent to the abandoned rail lines in some areas, or from the same migration mechanisms acting on the rail beds themselves; and
- The three COPCs (cadmium, lead, and zinc) were detected above their respective Residential Soil RSLs.

Figure 2.3 presents the CSM developed for the site, and includes a visual depiction of the pathway

for mining-related wastes to enter the environment. Section 2.5 discusses the conceptual exposure models for human health and ecological risk developed to identify potentially exposed populations by tracking contaminant movement in the environment from the source to receptor.

Analytical data from the RI and previous investigations indicate that COPC metals are present in the chat supplied as rail road ballast, in the surface and subsurface soils of the rail beds that are predominantly weathered chat, and also in the underlying native soils at concentrations that exceed their Residential Soil RSLs. This is supported by analytical data indicating that elevated metals concentrations generally decreased significantly in samples of native soils versus the overlying weathered chat.

The near-surface soils present in Cherokee County include many silts and clays, which also underlie the weathered chat. Organic materials in the silts and the fine-grained nature of the clays make it likely that metals weathering and leaching from the chat would bind tightly to the soil particles and become immobile in the environment. The COPC metals have a tendency to adsorb to soils and their mobility is highly limited, especially in the case of fine-grained soils and/or soils with high content of organic matter. Soils and sediments can become sinks for heavy metals. Metals generally have low water solubility, resulting in limited ability to dissolve in surface water or groundwater under ambient conditions. They also tend to partition out of the aqueous phase onto organic matter or fine-grained soil particles. These properties combined with their natural corrosion resistance lead to their being immobile and persistent in the environment. Sorption and precipitation to soil particles, metal oxides, and organic matter are the primary means of entrainment of metals contamination in the environment.

2.5 RISK ASSESSMENT OVERVIEW

The following risk assessment discussion is taken from the RI Report (HGL, 2016). The HHRA and streamlined ERA were performed by EPA and are included in the RI Report as Appendices J and K, respectively. The risk assessments were conducted using soil data from the RI and additional data from surface water and sediment samples collected by EPA.

2.5.1 Human Health Risk Assessment Summary

An HHRA was conducted for the site consistent with current EPA guidelines for HHRA at Superfund sites (USEPA 1989; 1991a; 1991b; 1992a; 2002a; 2002b; 2004; 2009). Site characterization data collected during the RI was used in the HHRA to evaluate possible health risks for recreational visitors and hypothetical future construction/excavation workers within the study area (EPA, 2015a). Assumptions, methods, and results are summarized below.

High- and low-frequency recreational visitors and hypothetical future workers were identified as potentially exposed receptors for CCR OU8. Recreational visitors (child, adolescent, and adult) are those who may walk, hike, play, and/or trespass along the historic rail lines in the area and be exposed via direct contact to surface soils along the rail beds. The hypothetical future worker represents construction/excavation workers who may be exposed via direct contact to surface and subsurface soils along the rail beds.

The exposure pathways identified and evaluated in the HHRA include: incidental ingestion of surface and subsurface soil, dermal contact with surface and subsurface soil, and inhalation of airborne soil particles.

Based on the results of the HHRA, human health risks for the recreational visitor (child, adolescent, and adult) and hypothetical future worker were below non-cancer hazard indexes (HIs) of 1, and cancer risks were within the EPA's target risk range of 1E-06 to 1E-04 for non-lead metals. For lead, using the Integrated Exposure Uptake Biokinetic (IEUBK) model for children and the Adult Lead Methodology (ALM) for adults, the probability that blood lead levels would exceed 10 micrograms per deciliter (µg/dL) were below the EPA's health based guideline (≤ 5 percent) for all receptors.

2.5.2 Ecological Risk Assessment Summary

The ERA for CCR OU8 was conducted in accordance with EPA's *Ecological Risk Assessment Guidance for Superfund* (EPA, 1992b), supplemented with more recent guidance and policy as appropriate (EPA, 2015b). Site characterization data collected during the RI completed by HGL, and samples collected from additional matrices by EPA were used in the ERA to evaluate possible health risks for wildlife within the study area. Assumptions, methods, and results are summarized below.

During the years the mines operated, railroads were constructed in Cherokee County to join conventional large-scale railroads to the individual mining operations. Historically, the ballast used in the railroad beds was composed of chat from surrounding mine waste piles. Metals present in the chat could potentially migrate into the underlying soil. Additional migration pathways include soil to surface water/sediment, air to soil, and bioaccumulation. The potentially exposed ecological populations include benthic organisms, fish, terrestrial plants, soil organisms, and wildlife receptors (birds and mammals).

In terms of ecological receptors, the media of concern consist of potentially contaminated surface soil, surface water, and sediment. Exposure can occur through direct contact with these media. For birds and mammals, exposure pathways also include ingestion of surface water, incidental ingestion of soil and sediment, and consumption of food (e.g., plants, invertebrates, fish, mammals) with contaminants accumulated in the tissue. Although animals can inhale soil contaminants in dust, the inhalation pathway contributes negligibly as compared to the ingestion exposure route and thus is not typically evaluated. Fur and feathers minimize the potential for dermal absorption of contaminants.

EPA determined that a simplified approach focusing on lead and zinc could be taken in the ERA to develop cleanup levels for soils because of the limited wildlife exposure to rail line contamination at OU8. Although cadmium concentrations were elevated at every rail line location, the high concentrations of zinc appear to diminish the toxicity of cadmium by interfering with the absorption of cadmium. This phenomenon has been noted by several researchers (Eisler, 1993; Fox et al., 1983; Kowalczyk et al., 1984). The high zinc-to-cadmium ratio (approximately 150 to 1) and the close correlation between these two elements likely protects terrestrial food chains somewhat from cadmium toxicity (Chaney et al., 2001).

The cleanup levels developed for lead and zinc are based on the same terrestrial assessment endpoint and corresponding exposure assumptions for vermivore receptors used to calculate the Cherokee County ecological cleanup levels. However, the toxicity reference value (TRV) accounts for a short-term (acute) exposure scenario. Although the TRV is based on acute effects, the limited area represented by rail lines was assumed to result in exposures that are even shorter in duration than the exposures used to estimate the acute TRVs. According to the ERA, this will be protective of sensitive species foraging on the rail line for a short period of time and, for zinc in particular, organisms should be able to recover from limited exposure to high zinc levels due to the physiological ability to regulate zinc. Based on these assumptions, the cleanup levels established in the ERA are 1,770 mg/kg for lead and 4,000 mg/kg for zinc. These clean-up levels would only be applicable to rail lines that have not been disturbed by land owners and are not surrounded by other mining related impacts. Only in these cases would the limited exposure assumptions apply.

The cleanup levels for sediment are based on the values established for the Tri-State Mining District (MacDonald et al., 2010). Finally, surface water cleanup levels are based on chronic National Ambient Water Quality Criteria, and are adjusted based on site-specific hardness. The cleanup levels are meant to represent concentrations above which animals may exhibit impaired health from exposure to metals.

Based on the assessment endpoints selected for the development of the Cherokee County cleanup levels, each of the 34 test pit locations and nine stream locations were considered separate exposure areas within the ERA.

The ERA results indicate that site-related contaminants in surface soil, surface water, and sediment may pose a threat to ecological receptors:

- Surface soil concentrations exceeded the ERA-established cleanup values for zinc at 29 locations and lead at 11 locations.
- Surface water contamination was identified at three sample locations. Based on nearby soil sample results, contamination at one of the locations appears to be attributable to the rail line.
- Sediment concentrations of zinc exceed cleanup levels at one location; however, the contamination does not appear to be attributable to the rail line.

Note that this FS covers surface soil contamination only. Surface water and sediment contamination are to be addressed under separate OUs.

2.5.3 Conclusions

Based on the results of the HHRA, no significant human health risks are identified for either the recreational visitor (child, adolescent, and adult) or hypothetical future worker, as all calculated non-cancer HIs and cancer risks were below target levels. The ERA results indicate that site-related contaminants in surface soil, surface water, and sediment may pose a threat to ecological receptors. Based on these results, lead and zinc were retained as soil COCs and evaluated in this FS. The cleanup levels established in the ERA are 1,770 mg/kg for lead and 4,000 mg/kg for zinc.

3.0 REMEDIAL ACTION OBJECTIVES

According to the National Contingency Plan (NCP) [40 Code of Federal Regulations [CFR] 300.430(a)(1)(i)], the goal of the remedy selection process is "to select remedies that are protective of human health and the environment, maintain protection over time, and minimize untreated waste." Preliminary RAOs are media-specific and source-specific goals achieved through completion of an RA that is protective of human health and the environment. These objectives are typically expressed in terms of the contaminant, the concentration of the contaminant, and the exposure route and receptor.

Preliminary RAOs are typically developed by evaluating several sources of information, including results of risk assessments and tentatively identified ARARs. These inputs provide the basis for determination of whether protection of human health and the environment is achieved for a remedial alternative.

The following sections present the ARARs, preliminary RAOs, and the cleanup levels that have been identified for the site.

3.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

EPA and the Kansas Department of Health and the Environment (KDHE) have tentatively identified regulations that may be applicable or relevant and appropriate to the Site. Appendix A provides the initial identification and detailed description of ARARs for the implementation of an RA at the Site as provided by EPA and KDHE. Final ARARs will be set forth in the ROD as performance standards for development of the remedial design and subsequent RA implementation.

Implementation of on-site RAs for the site would not require federal, state, or local permits in accordance with Section 121(e) of CERCLA. Necessary on-site RAs could include not only the contaminated area within the site boundary but also all areas in very close proximity to the contamination found at the site. The response must comply with all substantive requirements that are "applicable" or "relevant and appropriate." Off-site actions such as hauling, disposal, and borrow source development would not only require compliance with applicable requirements, but compliance with both substantive and administrative components of the applicable regulations as well. Table 3.1 contains a summary of the scope and intent of ARARs with regards to on-site and off-site actions.

Table 3.1
Scope and Extent of ARARs

	Scope of Requirements	Extent to Which Other Laws Apply
On-site Compliance	Substantive	Applicable or Relevant and Appropriate
Off-site Compliance	Substantive and Administrative	Applicable Requirements

3.1.1 Definition of ARARs

Section 121(d) of CERCLA, 42 United States Code (U.S.C.) § 9621(d), the NCP, 40 CFR Part 300 (1990), and guidance and policy issued by EPA require that RAs under CERCLA comply with substantive provisions of ARARs from state and federal environmental laws, and state facility siting laws during and at the completion of the RA. ARARs are designated as either "applicable" or "relevant and appropriate," according to EPA guidance. If a state or federal environmental law is determined to be either applicable or relevant and appropriate, compliance with the substantive requirements of that ARAR are mandatory under CERCLA and the NCP. Compliance with ARARs is a threshold criterion that any selected remedy must meet unless a legal waiver as provided by CERCLA Section 121(d) (4) is invoked.

Applicable Requirements
Applicable requirements specifically refer to cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental laws or state environmental and facility siting laws. These requirements address a hazardous substance, pollutant, contaminant, RA, location, or other circumstance found at a CERCLA site.

Relevant and Appropriate Requirements
Relevant and appropriate requirements specifically refer to cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental laws or state environmental or facility siting laws. These requirements are not directly applicable to hazardous substances, pollutants, contaminants, RAs, locations, or other circumstances at a CERCLA site, but address problems or situations sufficiently similar (relevant) to those encountered at the CERCLA site such that their use is well suited to the particular site.

The determination that a requirement is relevant and appropriate is a two-step process that consists of: (1) the determination if a requirement is relevant; and, (2) the determination if a requirement is appropriate. In general, this involves a comparison of a number of site-specific factors, including an examination of the purpose of the requirement and the purpose of the proposed CERCLA action, the medium and substances regulated by the requirement and the proposed RA, the actions or activities regulated by the requirement and the RA, and the potential use of resources addressed in the requirement and the RA. When the analysis results in a determination that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable (EPA, 1988).

Other Requirements to be Considered
Many state requirements listed as ARARs are promulgated with identical or nearly identical requirements to federal law pursuant to delegated environmental programs administered by EPA

and the state. The preamble to the NCP provides that such a situation results in citation to the state provision and treatment of the provision as a federal requirement.

Also contained in this list are policies, guidance, or other sources of information which are "to be considered" in the selection of the remedy and implementation of the ROD. Although not enforceable requirements, these documents are important sources of information that EPA and the state may consider during selection of the remedy, especially in regard to the evaluation of public health and environmental risks, or which will be referred to, as appropriate, in selecting and developing cleanup actions [40 CFR § 300.400(g)(3), 40 CFR § 300.415(i)].

Waivers of Specific ARARs

CERCLA Section 121(d)(4) authorizes that any ARAR may be waived under one of the following six conditions if the protection of human health and the environment is assured:

1) It is part of a total RA that will attain such level or standard of control when completed (i.e. interim action waiver).
2) Compliance with the ARAR at a given site will result in greater risk to human health and the environment than alternative options that do not comply with the ARAR.
3) Compliance with such a requirement is technically impracticable from an engineering perspective.
4) The RA will attain a standard or performance equivalent to that required by the ARARs through use of another method or approach.
5) The ARAR in question is a state standard and the state has not consistently applied (or demonstrated the intention to consistently apply) the ARAR in similar circumstances at other sites.
6) In meeting the ARAR, the selected RA will not provide a balance between the need for protection of public health and welfare and the environment at the site and the availability of Superfund monies to respond to other facilities.

3.1.2 Identification of ARARs

ARARs are defined as chemical-, location-, or action-specific. An ARAR can be one or a combination of all three types of ARARs.

Chemical-specific requirements address chemical or physical characteristics of compounds or substances on sites. These values establish acceptable amounts or concentrations of chemicals that may be found in or discharged to the ambient environment.

Location-specific requirements are restrictions placed upon the concentrations of hazardous substances or the conduct of cleanup activities because they are in specific locations. Location-specific ARARs relate to the geographical or physical positions of sites, rather than to the nature of contaminants at sites.

Action-specific requirements are usually technology-based or activity-based requirements or limitations on actions taken with respect to hazardous substances, pollutants, or contaminants. A given cleanup activity will trigger an action-specific requirement. Such requirements do not themselves determine the cleanup alternative but define how chosen cleanup methods should be performed.

3.2 PRELIMINARY REMEDIAL ACTION OBJECTIVES

According to the NCP [40 CFR 300.430(a)(1)(i)], the goal of the remedy selection process is "to select remedies that are protective of human health and the environment, maintain protection over time, and minimize untreated waste." RAOs are medium-specific and source-specific goals to be achieved through completion of an RA that are protective of human health and the environment. These objectives typically are expressed in terms of the contaminant, the concentration of the contaminant, and the exposure route and receptor. They provide the basis for determining whether protection of human health and the environment is achieved for a remedial alternative.

Preliminary RAOs are typically developed by evaluating several sources of information, including results of the HHRA and preliminarily identified ARARs. During development of the preliminary RAOs, other remedial goals and interests may be considered that have been expressed by various Site stakeholders. Although these goals are not considered requirements pursuant to the NCP (40 CFR 300), they may serve to guide the remedial development process. The preliminary RAOs provide the foundation for the numerical cleanup levels, and remediation alternatives, which will be established by EPA in the ROD for the Site.

The preliminary RAOs identified for protection of ecological receptors for CCR OU8 are:

- Prevent exposure of ecological receptors to COCs in source materials that would potentially result in unacceptable ecological risks.
- Prevent exposure of ecological receptors to COCs in soils that would potentially result in unacceptable ecological risks.

3.3 PRELIMINARY CLEANUP LEVELS

This FS is focused on cleanup of soils, and does not address sediment or surface water. The ecological cleanup levels for soil were established in the ERA for OU8 (EPA, 2015). The cleanup levels are meant to represent concentrations above which animals may exhibit impaired health from exposure to metals. Preliminary cleanup levels for site COCs in soil are presented in Table 3.2.

Table 3.2
Preliminary Cleanup Levels for COCs

COCs	Cleanup Level for Soil (mg/kg)
Lead	1,770
Zinc	4,000

4.0 IDENTIFICATION AND SCREENING OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS

4.1 OVERVIEW

This section identifies GRAs, remedial technologies, and process options that are potentially useful to address the preliminary RAOs identified in Section 3.0 for the contaminated media. Screening of the GRAs, remedial technologies, and process options is then performed in accordance with the NCP to retain representative technologies and process options that can be assembled into remedial alternatives as discussed in Section 5.0.

The identification and screening process consists of the following general steps:

- Develop GRAs for the contaminated media that will satisfy the preliminary RAOs identified in Section 3.2.
- Compile remedial technologies and process options for each GRA that are potentially viable for remediation of the contaminated media.
- Screen the remedial technologies and process options with respect to technical implementability for the contaminated media at the site. Technologies and process options that are not technically implementable relative to the contaminated media are eliminated from further consideration in this FS.
- Evaluate and screen the retained remedial technologies and process options with respect to effectiveness, ease of implementability, and relative cost. Technologies and process options that have low effectiveness, low implementability, or high cost relative to the contaminated media are eliminated from further consideration in this FS.
- Combine and assemble the retained technologies and process options for the contaminated media into sitewide remedial alternatives as presented in Section 5.0.

This section categorizes the contaminated media and evaluates GRAs, technologies, and process options that are potentially viable for addressing the preliminary RAOs and ARARs discussed in Section 3.0.

4.2 GENERAL RESPONSE ACTIONS

GRAs are initial broad response actions considered to address the preliminary RAOs for the contaminated media identified as a concern at CCR OU8. GRAs include several remedial categories, such as containment, removal, disposal, and treatment of contamination within the media. Site-specific GRAs are first developed to satisfy the preliminary RAOs for the contaminated media and then are evaluated as part of the identification and screening of remedial technologies and process options for the contaminated media.

The GRAs considered for remediation of the source materials and contaminated soils are:

- No action
- Containment
- Source Removal
- Source Treatment

No action leaves contaminant media in their existing condition with no control or cleanup planned. In accordance with the NCP, this GRA must be considered to provide a baseline against which other options can be compared.

Containment includes such actions as capping, covering, armoring, or habitat modification. These actions are designed to reduce contaminant mobility, and biota exposure by physical separation.

Source Removal involves a complete or partial removal of contaminated media, followed by transport, consolidation, and disposal at an on-site/off-site location. These actions are designed to eliminate the exposure of biota to contaminants on site.

Source Treatment involves biological, chemical, thermal, and/or physical measures applied to the contaminated media that reduce toxicity, mobility, and/or volume of the contaminants present.

4.3 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

During this general scoping phase, a wide range of potential remedial technologies and process options were reviewed and the following determinations made:

- Remedial technologies/process options that should be eliminated and have no further consideration because they are unable to remediate the contaminated media due to site conditions or the lack of compatibility with the contaminated media.
- Remedial technologies/process options that are technically implementable but that should be eliminated and have no further consideration based on low effectiveness, low administrative implementability, and/or high cost for the contaminated media.
- Remedial technologies/process options that could provide remedial benefits in combination with other remedial technologies but would only have cost-effective application for specific site elements and particular conditions.
- Remedial technologies/process options that have substantial potential and applicability as a stand-alone remedy are being retained for further consideration.

Feasible remedial technologies and associated process options for the contaminated media were primarily identified using the Federal Remediation Technologies Roundtable (FRTR) Remediation Technologies Screening Matrix and Reference Guide, Version 4.0 (FRTR, 2002).

4.3.1 Identification of Potentially Applicable Technologies and Process Options

The following remedial technologies were identified during the general scoping phase of the FS:

- No Action.

- Containment – capping the contaminated media with a protective barrier using soil, geosynthetics, or vegetation.
- Source Removal - excavation, transport, consolidation, and disposal. Process options for source removal include partial excavation.
- Treatment - in situ or ex situ mixing of contaminated source materials and soil with amendments to make heavy metals less bioavailable and less leachable.

4.3.2 Screening of Potentially Applicable Technologies and Process Options

The remedial technologies in this section have been screened and identified for further consideration in developing remedial alternatives to satisfy the RAOs. Treatment of contaminated soil to reduce bioavailability of metals has not been found to be a technically feasible, readily implementable technology in past remedial efforts at the Cherokee County site. These types of technologies will not be carried forward for consideration in developing remedial alternatives to address site risks.

No-Action

The "no-action" GRA is required as a baseline alternative against which the effectiveness of the other alternatives can be compared. Under this alternative, no RAs are taken at the site. Current risks posed from contaminants at the site remain unmitigated, uncontrolled, and unmanaged. In accordance with the NCP, this GRA must be considered to provide a baseline against which other options can be compared.

Containment

Soil/clay caps, with a topsoil layer and vegetative cover, have been used extensively to immobilize contaminants and physically isolate biota from contaminated media. This technology is highly applicable to the Cherokee County site and will be carried forward for consideration in developing remedial alternatives to address the site risks.

Source Removal, Transport, Consolidation, and Disposal

Excavation of contaminated ballast and soil is an accepted and highly utilized technology for addressing risks at sites where mining waste is present. Excavation is easily implementable with readily available equipment and labor. For purposes of this FS, the excavation process option includes backfilling with clean soil, returning the property to its original elevation and grade, and revegetating. This technology will be carried forward for consideration in developing remedial alternatives to address site risks.

Consolidation and disposal of contaminated materials excavated is an accepted and highly utilized technology for addressing site risks. Consolidation and disposal are easily implementable with readily available equipment and labor. Consolidation and disposal would be either on-site or off-site. Alternate disposal and repository options will only be evaluated if they result in a cost savings. This technology will be carried forward for consideration in developing remedial alternatives to address the site risks.

Treatment

Treatment methods appropriate for heavy metals contamination are: pozzolanic stabilization, phosphate stabilization, and phytoextraction.

Pozzolanic stabilization. This method addresses metals in soils by the addition of a solidifying agent, such as Portland cement or fly ash, to form a monolith, similar to concrete. The pozzolan agent is added in situ by introducing a slurry mixture into the soil, then mixing with an auger. The monolith created would reduce leachability and mobility of metals in soils by reducing soil particle surface area and inhibiting human contact by encapsulating soils. The advantage of pozzolanic stabilization is that treatment materials are inexpensive and readily available. The limitations with in-place pozzolanic stabilization include increased material volume. The majority of the former rail beds are in rural areas, and in many times are in the middle of pastures or fields where "paved" areas would not be desirable. Therefore, this technology will not be carried forward for consideration in developing remedial alternatives to address the site risks.

Phosphate stabilization. This method is a chemical stabilization procedure in which phosphate salts are added to soils, sediments, and mine tailings in either solid or liquid form and mixed with the soil. Phosphate ions combine with heavy metals to form less soluble phosphate complexes. Although the metals are not removed, they become less bioavailable and are less likely to be absorbed when ingested. Phosphate can be added to the soil in the form of phosphoric acid, triple-super phosphate, or phosphate rock. Following application of the phosphoric acid, lime is added to raise the pH to acceptable levels and the area revegetated. Pilot scale studies performed at other sites have demonstrated that in the short-term, phosphate stabilization may reduce the bioavailability of lead by 30 to 50 percent in residential soils; however, it is only effective on lead concentrations less than 1,200 mg/kg (Mosby et al., 2006). Its effectiveness on chat is unknown because chat is not a fine-grained material like residential soils. In addition, the use of phosphoric acid, which is the most effective for long term stabilization of lead, may cause increased short term leaching of zinc (Mosby, et al., 2006). The data for the CCR site shows that zinc contamination above the cleanup levels is more widespread than lead contamination. Based on these reasons, this technology will not be carried forward for consideration in developing remedial alternatives to address the site risks.

Phytoextraction. This treatment method uses specific plants and soil amendments to increase uptake of heavy metals. Plants used for phytoextraction may accumulate concentrations of metals high enough to necessitate the disposal of plant matter as special waste. In addition, chat has little to no organic matter; therefore, it is likely to be problematic to establish vegetation in this medium. This technology will not be carried forward for consideration in developing remedial alternatives to address the site risks.

4.4 RETAINED GRAs, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS

Based on the results of the initial screening process described in Section 4.3, a reduced number of remedial technologies and process options for the contaminated media were retained for further evaluation and the development of RA alternatives. These retained remedial technologies and process options are presented in Table 4.1.

The retained remedial technologies and process options are assembled into remedial alternatives in Section 5.0.

Table 4.1
Retained Remedial Technologies and Process Options

General Response Action	Remedial Technology	Process Option
No Action	None	No action
Removal, Transport, Consolidation, and Disposal	Excavation	Excavate mining wastes and contaminated soil
	Hauling	Highway and off-road trucks
	Consolidation and Disposal	On- or off-site
Containment	Capping	Soil cap and vegetated soil cover

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5.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

5.1 OVERVIEW

In this section, RA alternatives (herein referred to as remedial alternatives) are assembled by combining the retained remedial technologies and process options presented in Section 4.0 for the contaminated medium. Remedial alternatives are developed from either stand-alone process options or combinations of the retained process options. The process options would be implemented in combinations for the contaminated medium of concern that would:

- Achieve threshold evaluation criteria (protection of human health and the environment and compliance with ARARs).
- Achieve preliminary RAOs to the extent possible (identified in Section 3.2).

These remedial alternatives are then screened using a qualitative process with standard evaluation to determine overall effectiveness, implementability, and cost. The purpose of alternative screening is to reduce the number of remedial alternatives retained for detailed analysis in the FS.

The remedial alternatives for OU8 span a range of categories defined by the NCP as follows:

- No action alternative.
- Alternatives that address the principal threats but involve little or no treatment; protection would be by prevention or control of exposure through actions such as containment and/or engineered controls and institutional controls (ICs).
- Alternatives that, as their principal element, employ treatment that reduces the toxicity, mobility, or volume of the contaminants.
- Alternatives that remove or destroy contaminants to the maximum extent, eliminating or minimizing long-term management.
- Alternatives that include treatment technologies.

5.2 ASSUMPTIONS AFFECTING DEVELOPMENT OF REMEDIAL ALTERNATIVES

Fundamental assumptions affect the development of remedial alternatives evaluated (other than the no action alternative). These assumptions are driven by requirements of the preliminary RAOs identified in Section 3.2 and site limitations and constraints that cannot be overcome by using one or more remedial technology/process options as described in Section 4.0. These fundamental assumptions were taken into consideration during development of remedial alternatives and include the items listed in Table 5.1.

Table 5.1
Assumptions Affecting Development of Remedial Alternatives

Fundamental Assumption	Rationale
Removal actions addressing zinc-contaminated soil would also address lead-contaminated soil.	Based on analytical data, all of the railway berm samples collected during the remedial investigation phase that contained elevated concentrations of zinc also had elevated concentrations of lead.
The soils underlying raised railway ballasts constructed of chat or other mining-related materials likely exceed the preliminary cleanup levels.	Surface water and precipitation falling on the railway areas can easily percolate down through the porous rail bed materials and leach metals into the underlying fine-grained soils.

5.3 DESCRIPTION OF REMEDIAL ALTERNATIVES

Remedial alternatives were assembled by combining the retained remedial technologies and process options. Table 4.1 provides a list of the retained remedial technologies/process options that were used to develop each remedial alternative. The fundamental site assumptions and factors described in Section 5.2 were also considered during development of the remedial alternatives.

The remedial alternatives evaluated were:

- Alternative 1: No Action
- Alternative 2: Source Removal, On-Site Waste Consolidation and Capping
- Alternative 3: Source Removal, Waste Consolidation and Capping at OU3/OU4 Consolidation Areas
- Alternative 4: Containment and Capping in Place

The following subsections provide generalized descriptions of the remedy components for remedial alternatives to be evaluated during the screening process presented in this section.

5.3.1 Alternative 1: No Action

A "no action" alternative is required by the NCP, 40 CFR § 300.430(e)(6), to provide an environmental baseline against which impacts of the various remedial alternatives can be compared. Under the no action alternative, all current remedial activities would cease and no further action would be taken at the site to remediate contaminated soils or address the associated risks to human health or the environment. Five-Year Reviews would be performed as required by the NCP to evaluate whether adequate protection of human health and the environment is provided.

5.3.2 Alternative 2: Source Removal, On-Site Waste Consolidation and Capping

Alternative 2 provides protection of ecological receptors through excavation and capping of contaminated materials on site to limit exposure. Under this alternative, all ballast and contaminated soil whose concentrations of lead and/or zinc exceed the preliminary cleanup levels would be excavated and then consolidated and capped in small containment areas on site. Excavated areas, assuming that some amount of soil below the footprint of the former rail bed may require removal, would be backfilled with clean fill. Vegetative cover would be established over the removal and capped areas to restore the property and to provide vegetative root systems to hold the soil in place, preventing erosion and off-site transport by surface runoff or wind.

Source Removal

This alternative includes the removal of contaminated material above and below grade and backfilling the excavation with clean soil. Railroad ballast material visually identified as chat would be removed and then the underlying area would be scanned using an XRF to verify that metals concentrations in the remaining soil are at or below preliminary cleanup levels. Excavation and removal of the underlying soil would continue until these criteria are met. A hydraulic excavator would be used to excavate the material and load dump trucks for transport and placement at on-site waste consolidation areas. The excavated areas would be backfilled with clean fill and graded to provide positive drainage. Erosion and sediment controls will be maintained for 1 year while the vegetative cover is being established on the backfilled areas.

On-Site Waste Consolidation and Capping

The excavated materials would be placed in consolidation areas at each work site or within a cluster of closely spaced small sites. A bulldozer or other grading equipment would be used to grade the mine waste in the consolidation areas. The consolidation area would be capped with 12 inches of locally available clayey soil and 6 inches of topsoil. This type of cap configuration has been successfully implemented at similar OUs in Cherokee County. ICs will be required so that the consolidation areas are not disturbed and contaminated materials becomes exposed. Operation and maintenance (O&M) will be required to maintain the integrity of the soil cover. For the purposes of this FS, this alternative assumes that sufficient cover soil and topsoil are available within a 10-mile radius of each site and in the quantities and time frame required for establishing vegetative growth. It also assumes that the consolidation areas will overlay a portion of the former rail beds (reducing the amount of material to be excavated) and that approximately 58 small containment areas will be needed.

5.3.3 Alternative 3: Source Removal, Waste Consolidation and Capping at OU3/OU4 Consolidation Areas

Alternative 3 provides protection of ecological receptors through excavation and removal, with disposal at OU3/OU4 consolidation areas. This alternative is similar to Alternative 2, as all ballast material and contaminated soil with metals concentrations exceeding the preliminary cleanup levels will be excavated and removed; however, these wastes would be transported to existing consolidation areas for consolidation and capping.

Source Removal

This alternative includes the same approach to removal of mining wastes and the underlying contaminated soil as described for Alternative 2.

Waste Consolidation and Capping

The excavated materials would be loaded into haul trucks and transported to a central consolidation area. For the purpose of estimating costs and level of effort, it is assumed that one of the proposed waste consolidation areas to be constructed as part of the OU4 Phase 3 Baxter/Treece RAs would have adequate capacity to receive these materials, would be located within a 20-mile radius of each removal area, and would actively be undergoing construction at the same time as the OU8 removal activities will be occurring.

5.3.4 Alternative 4: On-Site Capping

This alternative involves capping the waste in place to prevent ecological contact. The cap would consist of 12 inches of locally available clayey soil and 6 inches of topsoil. This type of cap configuration has been successfully implemented at similar OUs addressed as part of the previous Baxter Springs, Treece, Waco, and Lawton mine waste remedies. The alternative assumes that sufficient cover soil, topsoil, or soil amendments are available within a 10-mile radius of each site and in the quantities and time frame required for establishing vegetative growth. O&M will be required to maintain the integrity of the soil cover, which is expected to extend for approximately 39 miles along the rail lines.

5.4 SCREENING EVALUATION OF ALTERNATIVES

The purpose of the screening evaluation is to reduce the number of proposed remedial alternatives that undergo a more thorough and extensive analysis. Therefore, screened alternatives are qualitatively evaluated using a smaller set of screening evaluation criteria than criteria used to complete the detailed evaluation of retained alternatives after screening. Per the NCP guidance, each of these proposed alternatives is screened using the short- and long-term aspects (where applicable) of three broad criteria: effectiveness, implementability, and cost as described below:

Effectiveness

Effectiveness relates to the ability of the remedial alternative to satisfy screening evaluation criteria detailed in Table 5.2.

Table 5.2
Effectiveness Criteria

Effectiveness Criteria
Overall protection of human health and the environment[1]
Compliance with ARARs[1]
Short-term effectiveness (during the remedial construction and implementation period)
Long-term effectiveness and permanence (following remedial construction)
Reduction of toxicity, mobility, or volume through treatment

[1] These criteria are referred to as "threshold criteria" that an alternative must meet to be viable (except the "No Action" alternative).

Effectiveness of each of the proposed alternatives is judged against the five effectiveness screening criteria using the qualitative ratings system presented in Table 5.3.

Table 5.3.
Effectiveness Qualitative Ratings System

Effectiveness Ratings Categories	
❶	None
❶	Low
❷	Low to moderate
❸	Moderate
❹	Moderate to high
❺	High

Implementability

Implementability relates to the ability of the remedial alternative to satisfy screening evaluation criteria detailed in Table 5.4.

Table 5.4 Implementability Criteria

Criteria	Description
Technical feasibility	Ability to construct, reliably operate, and meet technology-specific regulations for process options until an RA is complete
	Ability to operate, maintain, replace, and monitor technical components after the RA is complete
Administrative feasibility	Ability to obtain approvals from other agencies
	Availability and capacity of treatment, storage, and disposal services
	Availability of property, specific materials and equipment, and technical specialists required for an RA

Implementability of each of the proposed alternatives is judged against the screening criteria using the qualitative ratings system presented in Table 5.5.

Table 5.5
Implementability Qualitative Ratings System

Implementability Ratings Categories	
❶	None
❶	Low
❷	Low to moderate
❸	Moderate
❹	Moderate to high
❺	High

Determination that an alternative is not technically feasible would usually preclude it from further consideration. Negative factors affecting administrative feasibility would normally involve coordination steps to lessen the negative aspects of the alternative but would not necessarily eliminate an alternative from consideration.

Cost

Cost estimates were not prepared for the screening evaluation. Instead, the relative cost of each alternative was used to rate the alternatives. The cost rating categories are as presented in Table 5.6.

Table 5.6
Cost Qualitative Ratings System

Cost Ratings Categories	
$	Low
$$	Low to moderate
$$$	Moderate
$$$$	Moderate to high
$$$$$	High

5.5 SUMMARY OF ALTERNATIVES SCREENING

Each alternative developed and described in Section 5.3 was evaluated to determine its overall effectiveness, implementability, and cost using the qualitative ratings system discussed in Section 5.4. Details on the alternative screening are presented in Appendix B. This evaluation and screening process is inherently qualitative in nature. The evaluation criteria described in Section 5.4 are specified by EPA guidance (EPA, 1988); however, the degree to which the criteria are weighted against each other are not specified. Determination of how the individual evaluation criteria influence the overall rankings requires engineering judgment.

Generally, alternatives with similar scope and essential components would have overall rankings that are similar, unless other considerations such as large differences in waste volumes or differing construction durations exist between them. Factors that affect the threshold criteria (overall protection of human health and the environment and compliance with ARARs) are given considerable weight in the overall ranking for effectiveness since alternatives must fully meet these criteria to be viable as a selected remedy.

Table 5.7 summarizes the results for the screening of alternatives for the site. The alternatives screening process involves a qualitative assessment of the degree to which remedial alternatives address evaluation criteria presented in Appendix B. The numerical designations for the qualitative ratings system used in this table are not used to quantitatively assess remedial alternatives (for instance, rankings for an alternative are not additive). Generally, alternatives that have a low rating for effectiveness and/or implementability coupled with a high cost would be eliminated from further consideration. No remedial alternatives have been eliminated from further consideration during this screening process.

Table 5.7
Summary of Alternatives Screening

Alternative	Description	Effectiveness	Implementability	Approx. Cost (Present Value Dollars)
1	No Action	⓿	❺	$
2	Source Removal, On-Site Waste Consolidation and Capping	❸	❸	$$$$
3	Source Removal, Waste Consolidation and Capping at OU3/OU4 Consolidation Areas	❹	❹	$$$$
4	On-Site Capping	❸	❸	$$

Legend for Qualitative Ratings System:

Effectiveness and Implementability		Cost (Present Value Dollars)	
⓿	**None**	⓿	**None**
❶	**Low**	$	**Low**
❷	**Low to Moderate**	$$	**Low to Moderate**
❸	**Moderate**	$$$	**Moderate**
❹	**Moderate to High**	$$$$	**Moderate to High**
❺	**High**	$$$$$	**High**

5.6 ALTERNATIVES RETAINED FOR DETAILED ANALYSIS

Table 5.8 summarizes the remedial alternatives retained for detailed analysis in Section 7.0 of this FS.

Table 5.8
Summary of Potential Remedial Alternatives

Alternative Designation	Remedial Alternative Title
1	No Action
2	Source Removal, On-Site Waste Consolidation and Capping
3	Source Removal, Waste Consolidation and Capping at OU3/OU4 Consolidation Areas
4	On-Site Capping

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6.0 DEFINITION OF CRITERIA USED IN THE DETAILED ANALYSIS OF RETAINED ALTERNATIVES

The remedial alternatives retained after completion of the preliminary alternative screening step of the FS process (summarized in Section 5.0) are evaluated using nine evaluation criteria. These criteria were developed to address statutory requirements and considerations for RAs in accordance with the NCP and additional technical and policy considerations that have proven to be important for selecting among remedial alternatives (EPA, 1988). Alternatives are further developed and evaluated in Section 7.0. The following subsections describe the nine evaluation criteria used in the detailed analysis of remedial alternatives and the priority in which the criteria are considered.

6.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Each alternative is assessed to determine whether it can provide adequate protection of human health and the environment (short- and long-term) from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site. Evaluation of this criterion focuses on how site risks are eliminated, reduced, or controlled through treatment, engineered controls, or institutional controls and whether an alternative poses any unacceptable cross-media impacts.

6.2 COMPLIANCE WITH ARARS

For this criterion, each alternative is evaluated to determine compliance with chemical-, location-, and action-specific ARARs. If the assessment indicates an ARAR will not be met, then the basis for justifying one of the six ARAR waivers allowed under CERCLA (Table 6.1) is discussed.

6.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Long-term effectiveness evaluates the likelihood that the remedy will be successful and the permanence that it affords. Factors to be considered, as appropriate, include the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their toxicity, mobility, or volume and propensity to bioaccumulate.
- Adequacy and reliability of controls that are used to manage treatment residuals and untreated waste remaining at the Site. This factor includes an assessment of containment systems and institutional controls to determine if they are sufficient to ensure that any exposure to humans is within protective levels. This factor also addresses the long-term reliability of management controls for providing continued protection from residuals, the assessment of the potential need to replace technical components of the alternative, and the potential exposure pathways and risks posed should the RA need replacement.

Table 6.1
ARAR Waivers

Waiver	Description
Interim Measures	The RA selected is only part of a total RA that will attain such level or standard of control when completed. (CERCLA §121(d)(4)(A).)
Greater Risk to Health and the Environment	Compliance with such requirement at the facility will result in greater risk to human health and the environment than alternative options. (CERCLA §121(d)(4)(B).)
Technical Impracticability	Compliance with such requirement is technically impracticable from an engineering perspective. (CERCLA §121(d)(4)(C).)
Equivalent Standard of Performance	The RA selected will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criteria, or limitation through use of another method or approach. (CERCLA §121(d)(4)(D).)
Inconsistent Application of State Requirements	With respect to a state standard, requirement, criteria, or limitation, the state has not consistently applied (or demonstrated the intention to consistently apply) the standard, requirement, criteria, or limitation in similar circumstances at other RAs. (CERCLA §121(d)(4)(E).)
Fund Balancing	In the case of an RA to be undertaken solely under Section 104 using the fund, selection of an RA that attains such level or standard of control will not provide a balance between the need for protection of public health and welfare and the environment at the facility under consideration and the availability of amounts from the fund to respond to other sites which present or may present a threat to public health or welfare or the environment, taking into consideration the relative immediacy of such threats. (CERCLA §121(d)(4)(F).)

6.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Each alternative is assessed for the degree to which it employs technology to permanently and significantly reduce toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the site. Factors to be considered, as appropriate, include the following:

- The treatment processes used and materials they will treat
- The amount of hazardous substances, pollutants, or contaminants that will be destroyed or treated, including how the principal threat(s) will be addressed
- The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment
- The degree to which the treatment is irreversible
- The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents
- Whether the alternative would satisfy the statutory preference for treatment as a principal element of the RA

6.5 SHORT-TERM EFFECTIVENESS

This criterion reviews the effects of each alternative during the construction and implementation phase of the RA until remedial response objectives are met. The short-term impacts of each alternative are assessed, considering the following factors, as appropriate:

- Short-term risks that might be posed to the community during implementation of an alternative
- Potential impacts on workers during RA and the effectiveness and reliability of protective measures
- Potential adverse environmental impacts resulting from construction and implementation of an alternative and the reliability of the available mitigation measures during implementation in preventing or reducing the potential impacts
- Time until protection is achieved

6.6 IMPLEMENTABILITY

The technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation are evaluated under this criterion. The ease or difficulty of implementing each alternative will be assessed by considering the factors detailed in Table 6.2.

Table 6.2
Implementability Factors to be Considered During Alternative Evaluation

Criteria	Factors to be Considered
Technical Feasibility	• Technical difficulties and unknowns associated with the construction and operation of a technology. • Reliability of the technology, focusing on technical problems that will lead to schedule delays. • Ease of undertaking additional RAs, including what, if any, future RAs would be needed and the difficulty to implement additional RAs. • Ability to monitor the effectiveness of the remedy, including an evaluation of risks of exposure should monitoring be insufficient to detect a system failure.
Administrative Feasibility	• Activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for offsite actions).
Availability of Services and Materials	• Availability of adequate off-site treatment, storage capacity, and disposal capacity and services. • Availability of necessary equipment and specialists and provisions to ensure any necessary additional resources. • Availability of services and materials plus the potential for obtaining competitive bids, which is particularly important for innovative technologies. • Availability of prospective technologies.

6.7 COST

Types of costs that are assessed for each alternative include the following:

- Capital costs
- Annual O&M costs
- Periodic costs
- Present value of capital and annual O&M costs

Cost estimates are developed according to *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA, 2000). Flexibility is incorporated into each alternative for the location of remedial facilities, the selection of cleanup levels, and the period in which RA will be completed. Assumptions of the project scope and duration are defined for each alternative to provide cost estimates for the various remedial alternatives. Important assumptions specific to each alternative are summarized in the description of the alternative. Additional assumptions are included in the detailed cost estimates in Appendix E.

The levels of detail employed in making these estimates are conceptual but are considered appropriate for making choices between alternatives. The information provided in the cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives.

The costs are evaluated with respect to the following categories:

- Capital costs are those expenditures that are required to construct an RA. They are exclusive of costs required to operate or maintain the action throughout its lifetime. Capital costs consist primarily of expenditures initially incurred to build or install the RA (e.g., excavation and backfilling of contaminated soil areas). Capital costs include all labor, equipment, and material costs (including contractor markups, such as overhead and profit) associated with activities, such as mobilization/demobilization; monitoring site work; and disposal. Capital costs also include expenditures for professional/technical services that are necessary to support construction of the RA.
- Annual O&M costs are those post-construction costs necessary to ensure or verify the continued effectiveness of an RA. These costs are estimated mostly on an annual basis. Annual O&M costs include all labor, equipment, and material costs (including contractor markups, such as overhead and profit) associated with activities, such as monitoring and maintenance. Annual O&M costs also include expenditures for professional/technical services necessary to support O&M activities.
- Periodic costs are those costs that occur only once every few years (such as Five Year Reviews, and equipment replacement) or expenditures that occur only once during the entire O&M period or remedial time frame (such as site closeout, remedy failure/replacement). These costs may be either capital or O&M costs but, because of their periodic nature, it is more practical to consider them separately from other capital or O&M costs in the estimating process.
- The present value of each alternative provides the basis for the cost comparison. The present value cost represents the amount of money that, if invested in the initial year of the RA at a given rate, would provide the funds required to make future payments to cover all costs associated with the RA over its planned life. Future O&M and periodic costs are included and reduced by a present value discount rate. The use of discount rates for present value cost analyses is stated in the preamble to the NCP (55 FR 8722) and in OSWER Directive 9355.3-20 (Revisions to Office of Management and Budget [OMB] Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis, 1993). As outlined in *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA, 2000), a 7 percent real discount rate should be applied over the period of evaluation for each alternative.

The 30-year nominal treasury interest rates (OMB, 2015) for the last 20 years (have generally been less than 6 percent, and inflation over the same period has averaged around 3 percent per year. Thus, the 7 percent real discount rate is not appropriate to use for estimating cost for the alternative evaluation in this FS at this time for the reasons cited. Based on the Table of Past Years Discount Rates from Appendix C of OMB Circular No. A-94, a discount rate of 1.5 % was applied to the cost calculations.

6.8 STATE ACCEPTANCE

This criterion evaluates the technical and administrative issues and concerns the state may have regarding each of the alternatives. Assessment of state concerns will be completed after comments on the FS and proposed plan have been received by EPA and are addressed in the ROD. Thus, state acceptance is not considered in the detailed evaluation of alternatives presented in this FS.

6.9 COMMUNITY ACCEPTANCE

Assessment of concerns from the public will be completed after comments on the FS and proposed plan have been received by EPA and are addressed in the ROD responsiveness summary. Thus, community acceptance is not considered in the detailed evaluation of alternatives presented in this FS.

6.10 CRITERIA PRIORITIES

The nine evaluation criteria are separated into three groups: threshold criteria, balancing criteria, and modifying criteria (Table 6.3). These criteria help prioritize among the factors that affect the remedial alternatives evaluation during detailed evaluation.

For this FS, threshold criteria are evaluated for each alternative using an acceptable or unacceptable pass/fail rating system, and balancing criteria are evaluated for each alternative using a qualitative rating system. The ratings system defines the ability of the alternative to satisfy each of the threshold and balancing criteria, with exception to cost. Cost is rated based on the actual cost provided in the cost estimate for each alternative. The qualitative ratings system definitions for the threshold and balancing criteria are provided in Table 6.4.

Table 6.3
Criteria Priorities

Group	Criteria	Definition
Threshold Criteria	• Overall Protection of Human Health and the Environment • Compliance with ARARs	Must be satisfied by the remedial alternative being considered as the preferred remedy.
Balancing Criteria	• Long-Term Effectiveness and Permanence • Reduction of Toxicity, Mobility, or Volume through Treatment • Short-Term Effectiveness • Implementability • Cost	Technical criteria evaluated among those alternatives satisfying the threshold criteria.
Modifying Criteria	• State Acceptance and Community Acceptance	Not evaluated in this FS; will be evaluated after comments are received on the FS and proposed plan.

Table 6.4
Ratings System for Evaluation of Alternatives

Ratings Categories for Threshold Criteria	Ratings Categories for Balancing Criteria
– Unacceptable	❶ None
+ Acceptable	❶ Low
	❷ Low to moderate
	❸ Moderate
	❹ Moderate to high
	❺ High

7.0 DETAILED ANALYSIS OF RETAINED ALTERNATIVES

7.1 OVERVIEW

In this section, remedial alternatives retained in Section 5.0 undergo detailed analysis. During detailed analysis, each alternative is assessed using the two threshold criteria and five balancing criteria presented in Section 6.0. The results of the detailed analysis for each remedial alternative are then arrayed to perform a comparative analysis of the alternatives and identify the key tradeoffs between them. The following alternatives were retained for detailed analysis:

Alternative 1: No Action

Alternative 2: Source Removal, On-Site Waste Consolidation and Capping

Alternative 3: Source Removal, Waste Consolidation and Capping at OU3/OU4 Consolidation Areas

Alternative 4: On-Site Capping

7.2 SECONDARY ASSUMPTIONS AFFECTING DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

Fundamental assumptions for all remedial alternatives used during alternative development and screening were presented in Section 5.0. However, there are numerous secondary assumptions that affect the detailed analysis of alternatives but are not fundamental controlling considerations. These assumptions are driven mainly by site limitations and constraints that cannot be overcome by using one or more retained remedial technology/process options as described in Section 4.0. Some of these secondary assumptions are grouped into distinct categories and include the items listed in Table 7.1.

Table 7.1
Secondary Assumptions Affecting Refinement and Detailed Analysis of Remedial Alternatives

Secondary Assumption Category	Secondary Assumption Description	Rationale
Waste Removal	All mining wastes visible at the ground surface will be removed, regardless of the concentrations of COCs in the material.	This is consistent with the EPA's position on waste removal on similar OUs in Cherokee County.
Waste Containment and Capping	The number of consolidation areas should be limited, if possible.	The KDHE's position during previous and ongoing phases of similar work at other OUs in Cherokee County has been to limit the number of waste consolidation areas. KDHE will be responsible for long term operation and maintenance of the consolidation areas; therefore, they prefer to have fewer areas to manage.
Remedial Action Scheduling	The construction activities can be scheduled to coincide with similar activities being conducted on OUs 3 and 4 in Baxter Springs and Treece, Kansas, and that there is sufficient space in the waste consolidation areas to be constructed in those OUs.	The OU8 construction activities are similar to those conducted during previous and ongoing phases of OUs 3 and 4. Scheduling the OU8 work to coincide with future work at OUs 3 and 4 and including it in the scope for OU4 will result in cost savings associated with putting the project out to bid and construction, as well as reducing the number of waste consolidation areas in the area.

7.3 ALTERNATIVES FOR CONTAMINATED SOIL

7.3.1 Alternative 1: No Action

7.3.1.1 Remedial Alternative Description

Alternative 1 is required by the NCP to provide an environmental baseline against which impacts of the various remedial alternatives can be compared. The only actions that would be implemented for Alternative 1 are completion of Five Year Reviews as required by the NCP. There would be no change in the soil contaminant concentrations because no treatment, containment, or removal of contaminated soil is included in this alternative.

7.3.1.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative 1 is provided in Table C.1A (Appendix C) using the evaluation criteria along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 1 is unacceptable. —

7.3.1.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative 1 is provided in Table C.1B (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the

justification for the rating. ARARs evaluated for this alternative are included in Appendix A. The overall rating on this criterion for Alternative 1 is unacceptable. ➖

7.3.1.4 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness and permanence for Alternative 1 is provided in Table C.1C (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 1 is none. 0️⃣

7.3.1.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 does not provide reduction of toxicity, mobility, or volume through treatment because treatment is not an option under Alternative 1. See Table C.1D (Appendix C) for a detailed evaluation of criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 1 is none. 0️⃣

7.3.1.6 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative 1 is provided in Table C.1E (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 1 is none. 0️⃣

7.3.1.7 Implementability

Evaluation of implementability for Alternative 1 is provided in Table C.1F (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 1 is high. 5️⃣

7.3.1.8 Cost

Evaluation of cost for Alternative 1 is provided in Table C.1G (Appendix C) using the evaluation criteria considerations along with the cost rating for each and the justification for the rating. Detailed cost estimates for this alternative are included in Appendix E. The present value cost for Alternative 1 is $103,000.

7.3.2 Alternative 2: Source Removal, On-Site Waste Consolidation and Capping

7.3.2.1 Summary of Remedial Alternative

Alternative 2 provides protection of ecological receptors through excavation and capping of contaminated materials to limit exposure and transport of contaminants. Under this alternative, all ballast and contaminated soil whose concentrations of lead and/or zinc exceed the preliminary cleanup levels would be excavated, consolidated, and capped in small on-site containment areas. For the purposes of this FS, it was assumed that the on-site containment areas would overlay a portion of the former rail bed and that some amount of soil below the footprint of the former rail bed may require removal. The excavated areas would be backfilled with clean fill and graded to provide positive drainage. Vegetative cover would be established over the backfilled area to restore

the property and to provide vegetative root systems to hold the soil in place, preventing erosion and off-site transport by surface runoff or wind. On-site consolidation areas would be constructed that overlay a portion of the former rail bed. The consolidation areas would be capped with 12 inches of clayey soil and 6 inches of topsoil. For the purposes of this FS, this alternative assumes that the consolidation areas will overlay a portion of the former rail beds (reducing the amount of material to be excavated) and that approximately 58 small containment areas will be needed. The components of Alternative 2 are described in detail in Section 5.3.2.

Based on the information provided in the RI, estimated volumes of materials that would need remediation were calculated and the methodology, assumptions, and calculations are included as Appendix D. Based on these calculations, approximately 266,000 cubic yards (CY) of material would require excavation and consolidation. Assuming that the excavations will be backfilled to provide positive drainage, the amount of backfill will be approximately 82,000 CY. An additional 176,000 CY of fill material will be required to construct the cover on the consolidation areas.

7.3.2.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative 2 is provided in Table C.2A (Appendix C) using the evaluation criteria along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 2 is acceptable. **+**

7.3.2.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative 2 is provided in Table C.2B (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. ARARs evaluated for this alternative are included in Appendix A. The overall rating on this criterion for Alternative 2 is acceptable. **+**

7.3.2.4 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness and permanence for Alternative 2 is provided in Table C.2C (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 2 is moderate to high. ❸

7.3.2.5 Reduction of Toxicity, Mobility, or Volume through Treatment

No off-site transportation and disposal will be implemented in this alternative. No treatment of soils will be conducted. See Table C.2D (Appendix C) for a detailed evaluation on this criterion using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 2 is low. ❶

7.3.2.6 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative 2 is provided in Table C.2E (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 2 is moderate. ❸

7.3.2.7 Implementability

Evaluation of implementability for Alternative 2 is provided in Table C.2F (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 2 is moderate to high. ❸

7.3.2.8 Cost

Evaluation of cost for Alternative 2 is provided in Table C.2G (Appendix C) using the evaluation criteria considerations along with the cost rating for each and the justification for the rating. Detailed cost estimates for this alternative are included in Appendix E. The present value cost for Alternative 2 is $14,965,000.

7.3.3 Alternative 3: Source Removal, Waste Consolidation and Capping at OU3/OU4 Consolidation Areas

7.3.3.1 Summary of Remedial Alternative

Alternative 3 provides protection of ecological receptors through RA (excavation and removal, vegetative cover) to limit exposure and transport of contaminants, as described above for Alternative 2. It also includes removal of all ballast and contaminated soil whose metals concentrations exceed the preliminary cleanup levels. These wastes would be transported to the OU3/OU4 consolidation areas for consolidation and capping. The remedy components of Alternative 3 are detailed in Section 5.3.3. Based on the methodology and assumptions presented in Appendix D, approximately 324,000 CY would require excavation and disposal and approximately 186,000 CY would be required for backfill to bring the excavation up to grade. It is assumed that the increase in the amount of materials needed to cover the consolidation areas is negligible for the purposes of this FS.

7.3.3.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative 3 is provided in Table C.3A (Appendix C) using the evaluation criteria along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 3 is acceptable. +

7.3.3.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative 3 is provided in Table C.3B (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. ARARs evaluated for this alternative are included in Appendix A. The overall rating on this criterion for Alternative 3 is acceptable. +

7.3.3.4 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness and permanence for Alternative 3 is provided in Table C.3C (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 3 is moderate to high. ❹

7.3.3.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Transportation and disposal will be implemented in this alternative; however, no treatment of soil is involved. See Table C.3D (Appendix C) for a detailed evaluation on this criterion using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 3 is low. ❶

7.3.3.6 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative 3 is provided in Table C.3E (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 3 is moderate. ❷

7.3.3.7 Implementability

Evaluation of implementability for Alternative 3 is provided in Table C.3F (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 3 is moderate to high. ❹

7.3.3.8 Cost

Evaluation of cost for Alternative 3 is provided in Table C.3G (Appendix C) using the evaluation criteria considerations along with the cost rating for each and the justification for the rating. Detailed cost estimates for this alternative are included in Appendix E. The present value cost for Alternative 3 is $16,028,000.

7.3.1 Alternative 4: On-Site Capping

7.3.1.1 Summary of Remedial Alternative

Alternative 4 also provides protection by capping of contaminated soils in place to limit exposure and transport of contaminants. The remedy components of Alternative 4 are detailed in Section 5.3.6. Approximately 211,000 CY of material would be required to cap the former rail bed in place, assuming an extent of 39 miles of rail lines in OU8.

7.3.1.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative 4 is provided in Table C.4A (Appendix C) using the evaluation criteria along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 4 is acceptable. ✚

7.3.1.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative 4 is provided in Table C.4B (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. ARARs evaluated for this alternative are included in Appendix A. The overall rating on this criterion for Alternative 4 is acceptable. +

7.3.1.4 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness and permanence for Alternative 4 is provided in Table C.4C (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 4 is moderate to high. ❸

7.3.1.5 Reduction of Toxicity, Mobility, or Volume through Treatment

No treatment of soil is included in this alternative. See Table C.4D (Appendix C) for a detailed evaluation on this criterion using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 4 is low. ❶

7.3.1.6 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative 4 is provided in Table C.4E (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 4 is moderate. ❸

7.3.1.7 Implementability

Evaluation of implementability for Alternative 4 is provided in Table C.4F (Appendix C) using the evaluation criteria considerations along with the qualitative rating for each and the justification for the rating. The overall rating on this criterion for Alternative 4 is moderate to high. ❸

7.3.1.8 Cost

Evaluation of cost for Alternative 4 is provided in Table C.4G (Appendix C) using the evaluation criteria considerations along with the cost rating for each and the justification for the rating. Detailed cost estimates for this alternative are included in Appendix E. The present value cost for Alternative 4 is $10,450,000.

7.4 COMPARATIVE ANALYSIS OF ALTERNATIVES

A comparative analysis of alternatives using each of the nine evaluation criteria, as required by federal regulation, is presented in this section. The purpose of this analysis is to identify the advantages and disadvantages of each alternative relative to the other alternatives. A separate comparison of the alternatives is presented under the heading of each criterion.

7.4.1 Protection of Human Health and the Environment

Protection of human health and the environment is addressed to varying degrees by the four evaluated alternatives. The No Action Alternative would have no effect on contaminated soil. Therefore, it does not address risks to human health.

Alternatives 2, 3, and 4 all provide protection by reducing exposure of ecological receptors to metals in ballast and contaminated soils. Permanence is provided in Alternatives 2 and 3 through removal and containment of contaminated materials with lead or zinc concentrations at or above their respective preliminary cleanup levels. Permanence is provided in Alternative 4 by capping the contaminated materials in place. Alternatives 2 and 4 leave contaminated materials on site; whereas Alternative 3 does not. Therefore, Alternative 3 is the most protective of human health and the environment.

7.4.2 Compliance with ARARs

The No Action Alternative would not meet ARARs, whereas the remainder of the alternatives meet federal and state ARARs. Chemical-, location-, and action-specific state and federal ARARs for the remainder of the alternatives would be achieved by making sure all materials exceeding cleanup levels is capped with a soil cover either on or off site. All alternatives except Alternative 1 would achieve ambient air quality regulations by keeping the duration of excavation to a minimum and by employing dust suppression measures while excavating and transporting contaminated soil. In addition, all alternatives except Alternative 1 would remove or cover all contaminated materials with concentrations greater than the preliminary cleanup levels and would achieve the goal of reducing the risk of exposure to ecological receptors.

7.4.3 Long-Term Effectiveness and Permanence

Alternative 1 would not provide long-term effectiveness for the protection of health and environment.

Under the remainder of the alternatives, the residual risks (the risk remaining after implementation) would be significantly reduced. The removal or capping of contaminated soil, ensures that future potential for exposure would be significantly reduced. Alternative 3 would provide the most permanence by removing all ballast and contaminated soils and disposing of them off site. Alternatives 2 and 4 would provide less permanence because contaminated materials would remain on site and could potentially be exposed if cover material were to become disturbed.

7.4.4 Reduction of Toxicity, Mobility or Volume

There would be no reduction in the toxicity, mobility, or volume of contamination under the No Action Alternative (Alternative 1).

Alternatives 2, 3, and 4 would significantly reduce the mobility of the contaminants on site. Only Alternative 3 reduces the volume of contaminants on site. None of the alternatives would reduce the toxicity of the contaminants.

7.4.5 Short-Term Effectiveness

There would be no short-term risk to workers for Alternative 1 because no remediation efforts would be performed. However, exposure pathways would remain.

Alternatives 2 and 3 would have increased short-term risks for the public, environment, and construction workers during excavation, backfilling, and transportation efforts. Disturbed contaminated soil could enter the ambient air during excavation and transportation. However, dust suppression measures would be implemented for the protection of community and workers during the RA. The alternatives would be lengthy to implement, requiring years to complete.

Alternative 3 has a higher airborne dust risks than Alternative 2 because of the increased haul distance and thus an extended duration to complete implementation of the remedial alternative.

Alternative 4 would have fewer short-term risks than Alternatives 2 or 3 because contaminated materials would not be excavated, but would be capped in place.

7.4.6 Implementability

Alternative 1 is highly implementable, requiring only Five-Year Reviews. The technologies involved in the remaining alternatives are readily implementable and are technically feasible from an engineering perspective. Earthwork is a typical construction operation. The experience from previous work conducted for the other Cherokee County OUs by the EPA have shown that all four of these alternatives would be readily implementable.

7.4.7 Cost

The total present value of the alternatives are estimated to be:

- Alternative 1 - $103,000
- Alternative 2 - $14,965,000
- Alternative 3 - $16,028,000
- Alternative 4 - $10,450,000

Detailed costs are presented in Appendix E.

No capital or O&M costs would be associated with Alternative 1 because no RAs would be conducted. However, it is assumed that Five-Year Review costs would be associated with Alternative 1 (periodic costs). Alternatives 2, 3, and 4 incur capital, O&M, and periodic costs. Capital costs include the RA work and implementation of ICs. O&M costs include inspections and maintenance of the consolidation areas to maintain the integrity of the caps. Periodic costs include Five-Year Reviews. Alternative 3 would have the lowest O&M costs as O&M and ICs would be required only for the consolidation areas that would be maintained as part of the OU3 and OU4 RAs.

7.4.8 State Acceptance

State acceptance of the alternatives will be fully determined after the public comment period closes for the Proposed Plan and this FS.

7.4.9 Community Acceptance

Community acceptance of the alternatives will be fully determined after the public comment period closes for the Proposed Plan and this FS.

7.4.10 Detailed Analysis Summary

A summary of the detailed analysis of alternatives described above is presented in Table 7.2.

Table 7.2
Summary of Comparative Analysis of Alternatives for the
Cherokee County OU8 Railroads Site

Remedial Alternative	Description	Threshold Criteria		Balancing Criteria				
		Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short-Term Effectiveness	Implementability	Present Value Cost (Dollars)
1	No Action	—	—	0	0	0	5	$103,000
2	Source Removal, On-Site Waste Consolidation and Capping	+	+	3	1	3	3	$14,965,000
3	Source Removal, Waste Consolidation and Capping at OU3/OU4 Consolidation Areas	+	+	4	1	2	4	$16,028,000
4	On-Site Capping	+	+	3	1	3	3	$10,450,000

Notes:

1. The numerical designations for the qualitative ratings system used in this table are not used to quantitatively assess remedial alternatives (for instance, individual rankings for an alternative are not additive).
2. Detailed cost spreadsheets (cost summaries, present value analyses, and cost worksheets) for each alternative are presented in Appendix E.

Legend for Qualitative Ratings System:

Threshold Criteria

— **Unacceptable**

\+ **Acceptable**

Balancing Criteria (Excluding Cost)

0 **None**

1 **Low**

2 **Low to Moderate**

3 **Moderate**

4 **Moderate to High**

5 **High**

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FIGURES

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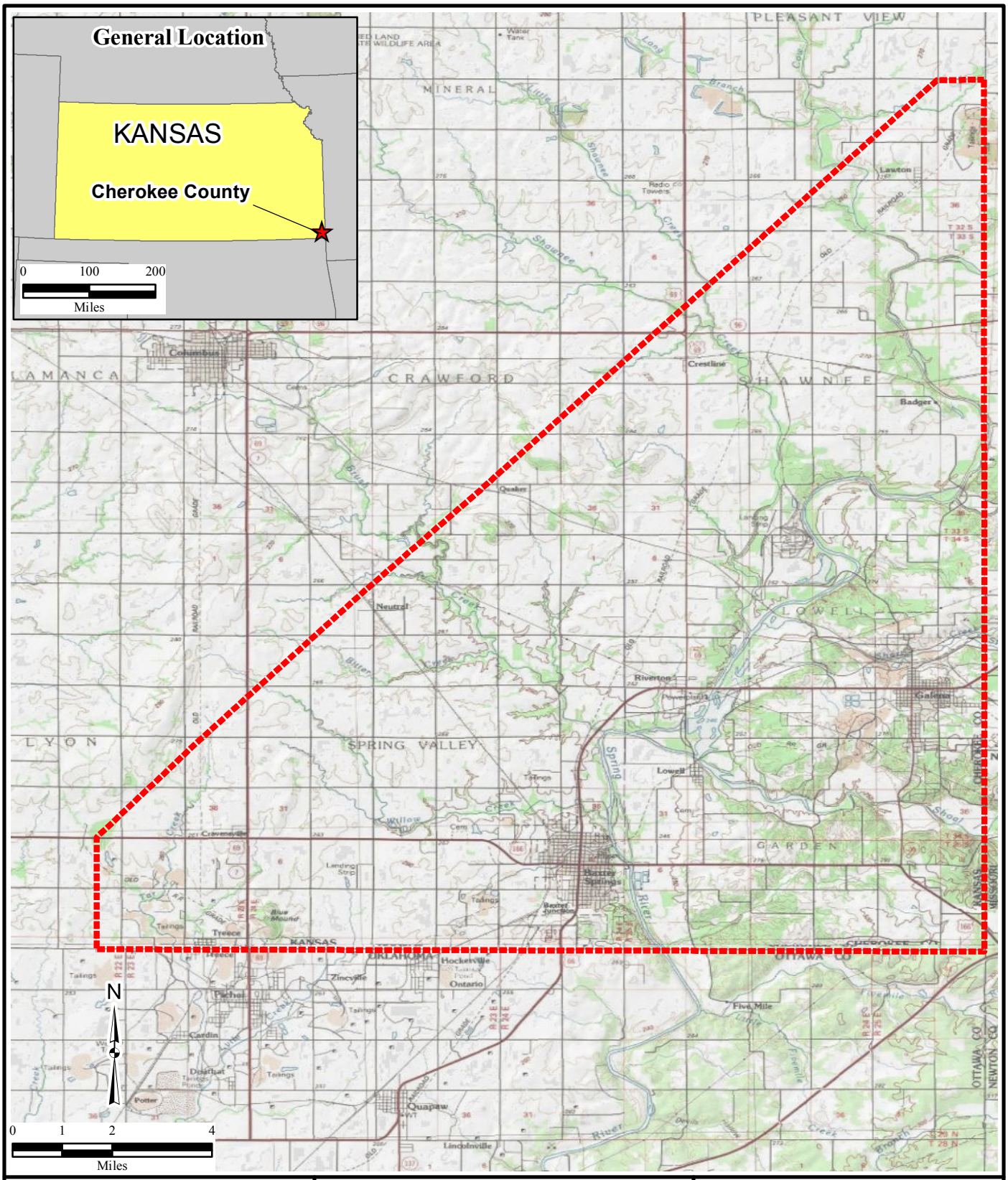

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Legend

Site Boundary

Figure 2.1
Site Location

HGL HydroGeoLogic, Inc

HGL—Feasibility Study for Cherokee County Site OU8
Railroads, Cherokee County, Kansas

Figure 2.2
Former Rail Line Classifications and Sample Locations

Legend

10 Sample Location

Site Boundary

Rail Classification

Active Line

Former Line

No Longer Present or Remediated

Addressed Under Other OU

A Rail Line Designation for Estimation of Volume of Material Requiring Remediation

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7/29/2016 JG
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ArcGIS Online USA Topo Map

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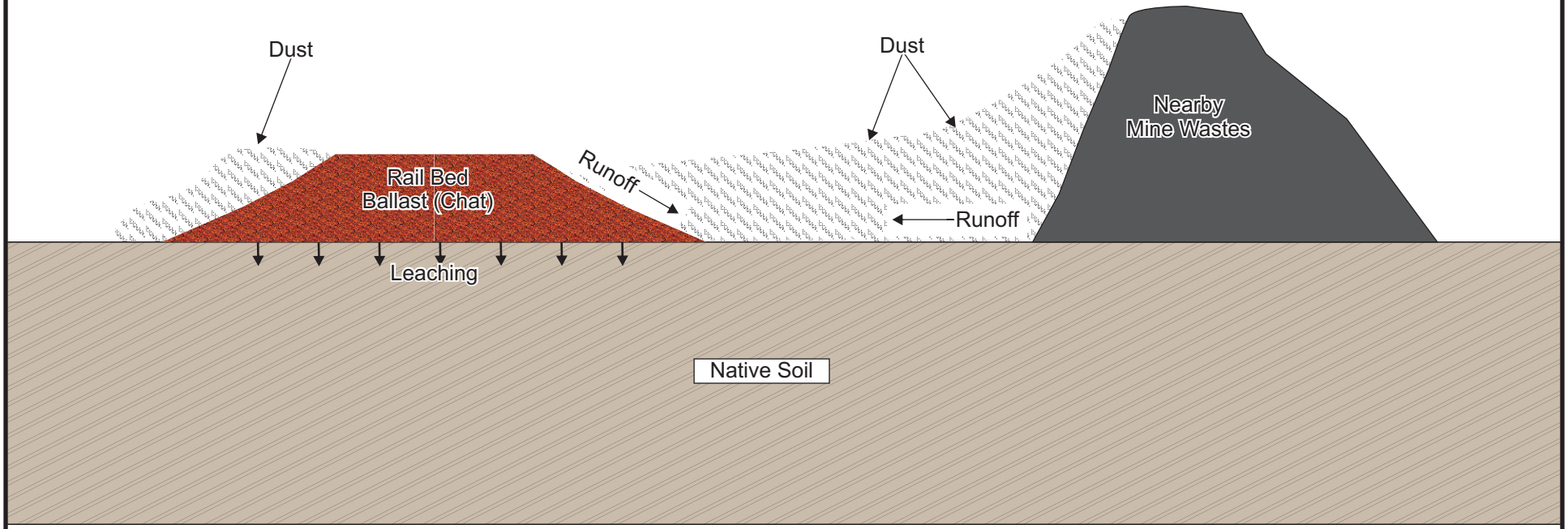
HGL HydroGeoLogic, Inc



Not to Scale

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Source: HGL

HGL HydroGeoLogic, Inc

Figure 2.3
Conceptual Site Model

APPENDIX A

SUMMARY OF FEDERAL AND STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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Table A.1
Federal Chemical-Specific ARARs

	Citations	Description
ARARS		
1. Clean Water Act	Water Quality Criteria 40 C.F.R. Part 131 Water Quality Standards	Establishes non-enforceable standards to protect aquatic life.
2. Clean Air Act	National Ambient Air Quality Standards/NESHAPS 42 U.S.C. 74112; 40 C.F.R. 50.6 and 50.12	Emissions standards for particulate matter and lead.
3. Resource Conservation and Recovery Act	42 U.S.C. Section 6901 40 C.F.R. 264 18(b)	Requires that any hazardous waste facility located within the 100-year floodplain be designed, constructed, operated, and maintained to avoid washout.
To Be Considered		
1. Draft Soil Screening Guidance	OSWER Directive 9355.4-14FS, December 1994. EPA/540/R-94/101 and 106	Describes the soil screening process and its application at CERCLA sites.
2. Revised Interim Soil Lead Guidance for CERCLA Sites	OSWER Directive No. 9355.4-12, August 1994	Guidance on site-specific preliminary Remediation Goals and soil lead cleanup at CERCLA sites.
3. Risk Management Derived Residential Yard Soils Remedial Action Levels for Lead and Cadmium	EPA Region 7 Record of Decision for the Baxter Springs and Treece subsites (OU3 and OU4) of the Cherokee County Superfund Site, 1997	Preliminary Remediation Goals for OU3 and OU4.

Table A.2
State Chemical-Specific ARARs

	Citations	Description
ARARS		
1. Kansas Clean Water Act	Water Quality Standards (WQS) KSA 65-170, KAR 28-16-28	WQS specific to stream classification.
2. Kansas Hazardous Waste Management Act	KSA 65-3430, KAR 28-31-1 to 28-31	Regulations involving the systematic control of the collection, storage, transportation, processing, treatment, recovery, and disposal of hazardous waste
To Be Considered		
1. Kansas Clean Water Law	Kansas Surface Water Quality Standards	Total Maximum Daily Load Regulations

Table A.3
Federal Location-Specific ARARs

	Citations	Description
ARARS		
1. Historic project owned or controlled by a federal agency	National Historic Preservation Act: 16 U.S. Code (USC) 470, et.seq; 40 Code of Federal Regulations (CFR) § 6.301; 36 CFR Part 1	Property within areas of the Site is included in or eligible for the National Register of Historic Places. The remedial alternatives will be designed to minimize the effect on historic landmarks.
2. Site within an area where action may cause irreparable harm, loss, or destruction of artifacts	Archeological and Historic Preservation Act; 16 USC. 469, 40 CFR 6.30	Property within areas of the site may contain historical and archaeological data. The remedial alternative will be designed to minimize the effect on historical and archeological data.
3. Site located in area of critical habitat upon which endangered or threatened species depend	Endangered Species Act of 1973, 16 USC 1531-1543; 50 CFR Parts 17; 40 CFR 6.302. Federal Migratory Bird Act; 16 USC 703-712	Determination of the presence of endangered or threatened species. The remedial alternatives will be designed to conserve endangered or threatened species and their habitat; including consultation with the Department of Interior if such areas are affected.
4. Waters in and around the site	Clean Water Act, (Section 404 Permits) Dredge or Fill Substantive Requirements, 33 USC Parts 1251-1376; 40 CFR Parts 230, 231	Capping, dike stabilization, construction of berms and levees, and disposal of contaminated soil, waste material or dredged material are examples of activities that may involve a discharge of dredge or fill material. Five conditions must be satisfied before dredge and fill is an allowable alternative: 1. There must not be a practical alternative. 2. Discharge of dredged or fill material must not cause a violation of State water quality standards, violate applicable toxic effluent standards, jeopardize threatened or endangered species or injure a marine sanctuary. 3. No discharge shall be permitted that will cause or contribute to significant degradation of the water. 4. Appropriate steps to minimize adverse effects must be taken. 5. Determine long- and short-term effects on physical, chemical, and biological components of the aquatic ecosystem.

Table A.3 (Continued)
Federal Location-Specific ARARs

	Citations	Description
5. Areas containing fish and wildlife habitat	Fish and Wildlife Conservation Act of 1980, 16 USC Part 2901 et seq.; 50 CFR Part 83.9 and 16 U.S.C. Part 661, et seq.: Federal Migratory Bird Act, 16 USC Part 703	Regulates activity affecting wildlife and non-game fish. Remedial action will conserve and promote conservation of non-game fish and wildlife and their habitats.
6. Fish and Wildlife Coordination Act	16 USC Section 661 et seq.; 33 CFR Parts 320-330; 40 CFR 6.302	Requires consultation when a Federal department or agency proposes or authorizes any modification of any stream or other water body, and adequate provision for protection of fish and wildlife resources.
7. 100-year floodplain	Location Standard for Hazardous Waste Facilities - RCRA; 42 USC 6901; 40 CFR 264.18(b)	RCRA hazardous waste treatment and disposal. Facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout during any 100-year/24-hour flood.
8. Historic Site, Buildings, and Antiquities Act	16 USC Section 470 et seq., 40 CFR Section301(a), and 36 CFR Part 1	Requires Federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks and to avoid undesirable impacts on such landmarks.
To Be Considered		
1. Wetlands located in and around the site	Protection of Wetlands; Executive Order 11990; 40 CFR Part 6, Appendix A	Remedial actions may affect wetlands. The remedial action will be designed to avoid adversely impacting wetlands wherever possible including minimizing wetlands destruction and preserving wetland values.
2. Site located within a floodplain	Protection of Floodplains, Executive Order 11988;40 CFR Part 6.302, Appendix A	Remedial action may take place within a 100-year floodplain. The remedial action will be designed to avoid adversely impacting the floodplain in and around a potential future soil repository or residential actions to ensure that the action planning and budget reflects consideration of the flood hazards and floodplain management.

Table A.4
State Location-Specific ARARs

	Citations	Description
ARARS		
1. Kansas Non-game and Endangered	KSA 32-957 through 32-963, 32-1009 through 32-1012, and 32-1033; KAR 23-17-2 and KAR 115-15-3	Requirements for actions involving solid waste disposal areas or other actions impacting state listed species. Prohibits destruction, adverse modification of critical habitat, or taking of endangered or threatened species.
To Be Considered		
None		

Table A.5
Federal Action-Specific ARARs

	Citations	Description
ARARS		
1. Disposal of Solid Waste in a Landfill or a Potential Future Soil Repository and Closure of a Potential Future Soil Repository.	Subtitle D of RCRA, 42 U.S.C. 6907 et seq. and 6941, et seq.	Implements State or Regional Solid Waste Plans and implements federal and state regulations to control disposal of solid waste. The yard soils disposed in the landfill or potential future repository may not exhibit the toxicity characteristic and therefore, are not hazardous waste. However, these soils may be solid waste. Contaminated residential soils will be consolidated from yards throughout the site into a single location. The disposal of this waste material should be in accordance with regulated solid waste management practices.
2. Clean Water Act	Water Quality Criteria 40 C.F.R. Part 131 Water Quality Standards	Establishes non-enforceable standards to protect aquatic life.
3. Clean Air Act	National Ambient Air Quality Standards/ NESHAPS 42 U.S.C. 74112; 40 C.F.R. 50.6 and 50.12	Emissions standards for particulate matter and lead.
4. Transportation of excavated soils.	Hazardous Materials Transportation Regulations, 49 C.F.R. Parts 107, 171-177	Regulates transportation of hazardous materials.
5. NPDES Storm Water Discharge	40 C.F.R. Part 122.26; 33 U.S.C 402 (p)	Establishes discharge regulations for storm water.
6. Solid Waste Disposal Act	Hazardous Waste Management Systems General, 40 C.F.R. Part 260 to 268	Establishes procedures and definitions pertaining to solid and hazardous waste.
7. Solid Waste Disposal Act	Identification and Listing of Hazardous Waste, 40 C.F.R. Parts 261	Defines those solid wastes that are subject to regulations as hazardous wastes under 40 C.F.R. Parts 262-265and Parts 124, 270, and 271.
8. Solid Waste Disposal Act	Standards Applicable to Generators of Hazardous Waste, 40 C.F.R. Parts 262 to 262.11	Waste determination.
9. Solid Waste Disposal Act	Standards Applicable to Transporters of Hazardous Wastes, 40 C.F.R. Parts 263	Establishes standards that apply to persons transporting hazardous waste within the U.S. if the transportation requires a manifest under 40 C.F.R. Parts 262.

Table A.5 (Continued)
Federal Action-Specific ARARs

	Citations	Description
10. Solid Waste Disposal Act	Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities, 40 C.F.R. Parts 264 and 265	Establishes minimum national standards which define the acceptable management of hazardous waste for owners and operators of facilities that treat, store, or dispose of hazardous waste.
11. Solid Waste Disposal Act	Land Disposal, 40 C.F.R. Parts 268	Establishes a ban or restrictions on burial of wastes and other hazardous materials.
12. Solid Waste Disposal Act	Hazardous Waste Permit Program, 40 C.F.R. Parts 270	Establishes provisions covering RCRA permitting requirements.
13. Waters in and around the site.	Clean Water Act, (Section 404 Permits) Dredge or Fill Substantive Requirements, 33 U.S.C. Parts 1251-1376; 40 C.F.R. Parts 230, 231.	Capping, dike stabilization, construction of berms and levees, and disposal of contaminated soil, waste material or dredged material are examples of activities that may involve a discharge of dredge or fill material. Four conditions must be satisfied before dredge and fill is an allowable alternative: 1. There must not be a practical alternative. 2. Discharge of dredged or fill material must not cause a violation of State water quality standards, violate applicable toxic effluent standards, jeopardize threatened or endangered species or injure a marine sanctuary. 3. No discharge shall be permitted that will cause or contribute to significant degradation of the water. 4. Appropriate steps to minimize adverse effects must be taken. 5. Determine long- and short-term effects on physical, chemical, and biological components of the aquatic ecosystem.
To Be Considered		
None		

Table A.6
State Action-Specific ARARs

	Citations	Description
ARARS		
1. Kansas Hazardous Waste Management Act	KSA 65-3430, KAR 28-31-1 to 28-31	Regulations involving the systematic control of the collection, storage, transportation, processing, treatment, recovery, and disposal of hazardous waste.
To Be Considered		
None		

APPENDIX B

PRELIMINARY SCREENING OF REMEDIAL ALTERNATIVES

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Ratings System for Evaluation of Alternatives

Effectiveness and Implementability		Cost (Present Value Dollars)	
⓿	None	⓿	None
❶	Low	$	Low
❷	Low to Moderate	$$	Low to Moderate
❸	Moderate	$$$	Moderate
❹	Moderate to High	$$$$	Moderate to High
❺	High	$$$$$	High

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Alternative 1
No Action

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Table B.1A
Effectiveness Screening - Alternative 1

Effectiveness Criteria	Evaluation Summary
Overall protection of human health and the environment	• All soil contamination is left unremediated. • Unremediated soil contamination allows continued release and migration of COCs. • Exposure to metals-contaminated soils would be probable; thus, no protection is provided to biota in this alternative.
Compliance with ARARs	• The preliminary remediation goals (PRGs) established in the ROD for Cherokee County (OU3 and OU4) would not be met. • Action-specific ARARs addressing proper disposal and transportation of contaminated soils would not be met.
Short-term effectiveness (during the remedial construction and implementation period)	• No further remedial action (RA) would be undertaken to address contamination sources; thus, none of these criteria are met.
Long-term effectiveness and permanence (following remedial construction)	
Reduction of toxicity, mobility, or volume through treatment	
Overall Rating	❶

Table B.1B
Implementability Screening - Alternative 1

Implementability Criteria	Evaluation Summary
Ability to construct, reliably operate, and meet technology-specific regulations for process options until an RA is complete	• No further RA would be undertaken to address source materials and contaminated soils; thus, ability to meet this criterion is high.
Ability to operate, maintain, replace, and monitor technical components after the RA is complete	
Ability to obtain approvals from other agencies	• Contamination would be left unremediated and no RA would be undertaken; thus, there is no need to obtain approvals from other regulatory agencies.
Availability and capacity of treatment, storage, and disposal services	• No RA would be undertaken to address contaminated areas; thus, this criterion is not applicable.
Availability of property, specific materials and equipment, and technical specialists required for an RA	• Technical equipment and specialists are available for monitoring; thus, the ability to meet this criterion is high.
Overall Rating	❺

Table B.1C
Cost Screening – Alternative 1

Evaluation Factors for Cost	Overall Rating
Present Value Cost	$

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Alternative 2
Source Removal, On-Site Waste Consolidation and Capping

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Table B.2A
Effectiveness Screening - Alternative 2

Effectiveness Criteria	Evaluation Summary
Overall protection of human health and the environment	• All mining-related wastes with metals concentrations greater than the PRGs will be addressed through excavation and on-site disposal in capped containment areas. This will eliminate the exposure pathway. • Excavated contaminated materials will be replaced with clean fill and topsoil, and a vegetative cover (seeding) will be maintained to restore the property and prevent erosion. • Operation and maintenance (O&M) activities will be required to maintain the integrity of the cap so that it remains protective of human health and the environment. • Institutional controls (ICs) would be required to prohibit digging in containment areas and exposing the contaminated soils. • Monitoring in the form of Five-Year Reviews would be performed to ensure the protectiveness of the remedy.
Compliance with ARARs	• Removal of mining wastes and contaminated materials and placing them under a soil cover would physically address contaminant sources, thus meeting chemical-specific ARARs. • Location- and action-specific ARARs for the remedy would be addressed during implementation.
Short-term effectiveness (during the remedial construction and implementation period)	• Excavation and handling of mining wastes and contaminated soil could pose short-term risks to workers. • Safety measures such as use of personal protective equipment (PPE), dust suppression, and establishment of work zones would protect workers and the community during implementation.
Long-term effectiveness and permanence (following remedial construction)	• Long-term effectiveness is not entirely ensured since contaminated soil consolidated and capped on-site potentially poses a risk. • Long-term effectiveness of ICs for consolidation areas is not ensured, particularly on privately owned parcels. • O&M activities will be required to maintain the integrity of the cap so that it retains its long term effectiveness and permanence. • Monitoring and periodic risk evaluation updates would be performed through Five-Year Reviews to ensure the long-term effectiveness and permanence of the remedy.
Reduction of toxicity, mobility, or volume through treatment	• This alternative does not treat mining wastes or metals-contaminated soils.
Overall Rating	❸

Table B.2B
Implementability Screening - Alternative 2

Implementability Criteria	Evaluation Summary
Ability to construct, reliably operate, and meet technology-specific regulations for process options until an RA is complete	• Removal, consolidation, and capping has been successfully implemented at mining sites in other OUs in Cherokee County and is relatively straightforward. • Excavating and backfilling around streams, drainage ways, and in flood plains may be challenging at specific locations. • Contaminated wastes can be transported using off-road trucks or general highway haul trucks. • ICs for the many small consolidation areas needed under this alternative may be difficult to implement and reliably operate, especially for privately owned parcels, due to types of ownership, levels of occupancy, and land use
Ability to operate, maintain, replace, and monitor technical components after the RA is complete	• Periodic monitoring and risk evaluation updates across the site would be a continuous process. • O&M activities, including inspection, maintenance, and repair will be required to maintain the integrity of the cap. These O&M activities are usually easy to implement; however, the number of small consolidation and capped areas may hinder the ease at which these activities are implemented. • Enforcement of ICs for the many on-site consolidation areas required may be difficult, especially for privately owned land due to types of ownership, levels of occupancy, and land use.
Ability to obtain approvals from other agencies	• Regulatory approval needed for removals and to construct on-site disposal facilities may be difficult to obtain given the number of individual containment areas. • Identification of off-site borrow sources for backfill and cover materials would require coordination and approval from the regulatory agencies. • Regulatory approvals for monitoring and engineered controls should be obtainable. • Regulatory approvals for ICs for on-site consolidation areas may be difficult to obtain given the large number of small containment areas required under this alternative.
Availability and capacity of treatment, storage, and disposal services	• The availability of sufficient area to accommodate an on-site consolidation area at each removal area is unknown. Consolidating wastes from several nearby or adjacent rail line removal areas likely would be required.
Availability of property, specific materials and equipment, and technical specialists required for an RA	• Access to privately owned parcels for implementing the RA must be obtained. • Labor, equipment, and materials for excavation, backfill, and cover construction are available. • Contaminant-free backfill and topsoil materials would be required from off-site sources. These materials would also need to be able to support vegetative growth. • Materials, equipment, and labor resources used for ICs and monitoring are easily obtainable.
Overall Rating	❸

Table B.2C
Cost Screening - Alternative 2

Evaluation Factors for Cost	Overall Rating
Present Value Cost	$$$$

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Alternative 3
Source Removal, Off-Site Waste Consolidation and Capping

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Table B.3A
Effectiveness Screening - Alternative 3

Effectiveness Criteria	Evaluation Summary
Overall protection of human health and the environment	• All mining-related wastes with metals concentrations greater than the PRGs will be addressed through excavation and off-site disposal in capped containment areas. This will eliminate the exposure pathway. No contaminated materials will remain at the location of the former rail bed. • Excavated contaminated materials will be replaced with clean fill and topsoil, and a vegetative cover (seeding) will be maintained to restore the property and prevent erosion. • Operation and maintenance (O&M) activities will be required to maintain the integrity of the cap so that it remains protective of human health and the environment. • ICs would be required to prohibit digging in containment areas and exposing the contaminated soils. • Monitoring in the form of Five-Year Reviews would be performed to ensure the protectiveness of the remedy.
Compliance with ARARs	• Removal of mining wastes and contaminated materials would physically address contaminant sources, thus meeting chemical-specific ARARs. • Location- and action-specific ARARs for the remedy would be addressed during implementation.
Short-term effectiveness (during the remedial construction and imple-mentation period)	• Excavation and handling of mining wastes and contaminated soil could pose short-term risks to workers. • Safety measures such as use of personal protective equipment (PPE), dust suppression, and establishment of work zones would protect workers and the community during implementation.
Long-term effectiveness and permanence (following remedial construction)	• Long-term effectiveness and permanence for parcels containing the former rail beds is addressed through excavation and off-site disposal, so that no contaminants remain at the former rail beds. • Long-term effectiveness for off-site consolidation areas is not entirely ensured since contaminated soil potentially poses a risk if exposed. • Long-term effectiveness of ICs for consolidation areas is not ensured, particularly on privately owned parcels. • O&M activities will be required to maintain the integrity of the cap so that it retains its long term effectiveness and permanence. • Monitoring and periodic risk evaluation updates would be performed through Five-Year Reviews of the off-site consolidation areas to ensure the long-term effectiveness and permanence of the remedy.
Reduction of toxicity, mobility, or volume through treatment	• This alternative does not treat mining wastes or metals-contaminated soils.
Overall Rating	❹

Table B.3B
Implementability Screening - Alternative 3

Implementability Criteria	Evaluation Summary
Ability to construct, reliably operate, and meet technology-specific regulations for process options until an RA is complete	• Removal and consolidation at an off-site containment area has been successfully implemented at mining sites in other OUs in Cherokee County and is relatively straightforward. • Excavating and backfilling around streams, drainage ways, and in flood plains may be challenging at specific locations. • Contaminated soil can be transported using general highway haul trucks.
Ability to operate, maintain, replace, and monitor technical components after the RA is complete	• Inspection, maintenance, and replacement of vegetative covers during the first year are relatively easy to implement.
Ability to obtain approvals from other agencies	• Regulatory approval needed for removals and disposal at off-site consolidation areas already under construction during ongoing RA at OUs 3 and 4 should be obtainable; Kansas Department of Health and the Environment (KDHE) has historically been involved with the design, construction, and O&M phases at similar mining sites in nearby OUs in Cherokee County. • Identification of off-site borrow sources for backfill would require coordination and approval from the regulatory agencies. • Regulatory approvals for ICs for off-site consolidation areas should be obtainable.
Availability and capacity of treatment, storage, and disposal services	• Sufficient area to accommodate off-site disposal in approved consolidation areas concurrently under construction for OUs 3 and 4 should be readily available
Availability of property, specific materials and equipment, and technical specialists required for an RA	• Access to privately owned parcels for implementing the RA must be obtained. • Labor, equipment, and materials for excavation and backfill are available. • Contaminant-free backfill and topsoil materials would be required from off-site sources. These materials would also need to be able to support vegetative growth. • Materials, equipment, and labor resources used for ICs and monitoring are easily obtainable.
Overall Rating	❹

Table B.3C
Cost Screening - Alternative 3

Evaluation Factors for Cost	Overall Rating
Present Value Cost	$$$$$

Alternative 4
On-Site Capping

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Table B.4A
Effectiveness Screening - Alternative 4

Effectiveness Criteria	Evaluation Summary
Overall protection of human health and the environment	• All mining-related wastes with metals concentrations greater than the PRGs would be capped with an 18-inch soil barrier consisting of 12 inches of clayey soil topped by 6 inches of topsoil to eliminate the exposure pathway. • O&M activities will be required to maintain the integrity of the cap so that it remains protective of human health and the environment. • ICs would be required to prohibit disturbance of the containment areas which would expose the contaminated soils. • Monitoring in the form of O&M inspections and Five-Year Reviews would be performed to ensure the protectiveness of the remedy.
Compliance with ARARs	• Capping of mining wastes and contaminated materials would physically address contaminant sources, thus meeting chemical-specific ARARs. • Location- and action-specific ARARs for the remedy would be addressed during implementation.
Short-term effectiveness (during the remedial construction and imple-mentation period)	• Construction of the cap could pose short-term risks to workers. • Safety measures such as use of personal protective equipment (PPE), dust suppression, and establishment of work zones would protect workers and the community during implementation.
Long-term effectiveness and permanence (following remedial construction)	• Long-term effectiveness is not entirely ensured since contaminated materials capped on-site potentially poses a risk. • Operation and maintenance (O&M) activities will be periodically required to repair the cap and maintain its integrity. • Long-term effectiveness of ICs for consolidation areas is not ensured, particularly on privately owned parcels. • Monitoring and periodic risk evaluation updates would be performed through Five-Year Reviews to ensure the long-term effectiveness and permanence of the remedy.
Reduction of toxicity, mobility, or volume through treatment	• This alternative does not treat mining wastes or metals-contaminated soils.
Overall Rating	❸

Table B.4B
Implementability Screening - Alternative 4

Implementability Criteria	Evaluation Summary
Ability to construct, reliably operate, and meet technology-specific regulations for process options until an RA is complete	• Capping contaminated materials is relatively straightforward and has been successfully implemented at mining sites in other OUs in Cherokee County. • Construction of the cap around streams, drainage ways, and in floodplains may be challenging at specific locations. • Materials for the cap can be transported using off-road or general highway haul trucks. • ICs for the capped rail beds may be more difficult to implement and reliably operate given the liner length of the rail bed, especially for privately owned parcels, due to types of ownership, levels of occupancy, and land use.
Ability to operate, maintain, replace, and monitor technical components after the RA is complete	• Periodic monitoring and risk evaluation updates across the site would be a continuous process. • Inspection, maintenance, and replacement of cap material is relatively easy to implement. • Implementation of O&M monitoring is easily implemented. • Maintenance of ICs may be difficult given the linear length of the capped area, especially for privately owned parcels due to types of ownership, levels of occupancy, and land use.
Ability to obtain approvals from other agencies	• Regulatory approval needed to construct a cap of this magnitude may be difficult to obtain. • Identification of off-site borrow sources for cover materials would require coordination and approval from the regulatory agencies. • Regulatory approvals for ICs for the capped areas may be difficult to obtain given the extent of the capped areas and the fact that they traverse multiple properties. Difficulties may be encountered with regard to types of restrictions, especially on privately owned parcels.
Availability and capacity of treatment, storage, and disposal services	• Not applicable.
Availability of property, specific materials and equipment, and technical specialists required for an RA	• Access to privately owned parcels for implementing the RA must be obtained. • Labor, equipment, and materials for construction of the cap are available. • Contaminant-free backfill and topsoil materials would be required from off-site sources. These materials would also need to be able to support vegetative growth. • Materials, equipment, and labor resources used for ICs and O&M are readily obtainable.
Overall Rating	❸

Table B.4C
Cost Screening - Alternative 4

Evaluation Factors for Cost	Overall Rating
Present Value Cost	$$

APPENDIX C

DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

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Ratings System for Evaluation of Alternatives

Ratings Categories for Threshold Criteria	Ratings Categories for Balancing Criteria
— Unacceptable	⓿ None
+ Acceptable	❶ Low
	❷ Low to moderate
	❸ Moderate
	❹ Moderate to high
	❺ High

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Alternative 1
No Action

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Table C.1A
Evaluation Summary for Overall Protection of Human Health and the Environment – Alternative 1

Evaluation Factors for Overall Protection of Human Health and the Environment	Evaluation Summary
Adequate protection of human health and the environment (short- and long- term) from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the Site	• The no action alternative does not address unacceptable risks posed by hazardous contaminants at properties. Therefore, this criterion is not met.
Overall Protection of Human Health and the Environment Rating:	—

Table C.1B
Evaluation Summary for Compliance with ARARs – Alternative 1

Evaluation Factors for Compliance with ARARs	Evaluation Summary
Compliance with Chemical-Specific ARARs	• No action is taken to address soil contamination; therefore, this criterion is not met.
Compliance with Location-Specific ARARs	• No remedial action (RA) would occur to address soil contamination; therefore, location-specific ARARs would not be triggered.
Compliance with Action-Specific ARARs	• No RA would occur to address soil contamination; therefore, action-specific ARARs would not be triggered.
Compliance with ARARs Rating:	—

Table C.1C
Evaluation Summary for Long-Term Effectiveness and Permanence – Alternative 1

Evaluation Factors for Long-Term Effectiveness and Permanence	Evaluation Summary
Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities	• No further RA would be undertaken to address soil contamination; therefore, this criterion is not met.
Adequacy and reliability of controls that are used to manage treatment residuals and untreated waste remaining at the site	• No controls are put in place under this alternative. • Contaminated soil remains uncontained at the Site.
Long-Term Effectiveness and Permanence Rating:	O

Table C.1D
Evaluation Summary for Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 1

Evaluation Factors for Reduction of Toxicity, Mobility, or Volume through Treatment	Evaluation Summary
The treatment process, the alternative uses, and materials they will treat	• The no action alternative does not address contaminated soil; therefore, these criteria are not met.
The degree of expected reduction in toxicity, mobility, or volume of contamination due to treatment	
The type and quantity of materials that will remain following treatment	
Whether the alternative would satisfy the statutory preference for treatment as a principal element of the RA.	
Reduction of Toxicity, Mobility, or Volume through Treatment:	⓿

Table C.1E
Short-Term Effectiveness Evaluation Summary – Alternative 1

Evaluation Factors for Short-Term Effectiveness	Evaluation Summary
Short-term risks that might be posed to the community during implementation of an alternative	• The short-term risks to the ecological community are unchanged by this alternative. No impacts to workers during implementation would occur and no adverse environmental impacts would occur during implementation; however, since short term risks are not addressed and the time frame is open ended, the criterion is not met.
Potential impacts to workers during implementation and the reliability of protective measures taken to minimize these impacts	
Potential adverse environmental impacts resulting from implementation of an alternative and the reliability of the available mitigation measure during implementation	
Short-Term Effectiveness Rating:	⓿

Table C.1F
Implementability Evaluation Summary – Alternative 1

Evaluation Factors for Implementability		Evaluation Summary
Technical Feasibility	Technical difficulties and unknowns associated with the construction and operation of a technology	• The no action alternative has no technical component and is therefore highly implementable.
	Reliability of the technology, focusing on technical problems that will lead to schedule delays	
Administrative Feasibility	Coordination issues with other office and agencies during construction or operations of the remedy.	• The no action alternative has no administrative component and is therefore highly implementable.
	The ability and time required to obtain necessary approvals and permits from other agencies for off-site actions or discharge scenarios	
Availability of Goods and Services	Availability of adequate off-site treatment, storage capacity, and disposal capacity and services	• The no action alternative would include limited periodic soil sampling in support of Five-Year Reviews; soil sampling is highly implementable.
	Availability of necessary equipment and specialists required to completed construction of remedy components	
	Availability of services and materials plus the potential for obtaining competitive bids	
	Availability of prospective technologies	
Implementability Rating:		❺

Table C.1G
Cost Evaluation Summary – Alternative 1

Evaluation Factors for Costs	Approximate Cost (Dollars)
Total Capital Costs	$0
Total Annual O&M Costs	$0
Total Periodic Cost	$133,000
Total Present Value Cost	$103,000

Note: Total costs are for the assumed period of evaluation (Years 1 through 30). Costs are rounded to the nearest $1,000.

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Alternative 2
Source Removal, On-Site Waste Consolidation, and Capping

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Table C.2A
Evaluation Summary for Overall Protection of Human Health and the Environment – Alternative 2

Evaluation Factors for Overall Protection of Human Health and the Environment	Evaluation Summary
Adequate protection of human health and the environment (short- and long- term) from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the Site	• All mining-related wastes with metals concentrations greater than the preliminary cleanup goals will be addressed through excavation and disposal of soils, which will eliminate the exposure pathway for biota. • Excavated contaminated materials will be replaced with clean fill and topsoil, and a vegetative cover (seeding) will be maintained to restore the property and prevent erosion. • Excavated materials will be placed in on-site consolidation areas and capped with 12 inches of clayey soil and 6 inches of topsoil to prevent future exposures. • Dust suppression would be practiced during excavation and consolidation to mitigate soil recontamination and off-site migration of lead contaminated dust. • Operation and maintenance (O&M) activities will be required to maintain the integrity of the cap so that it remains protective of human health and the environment. • Institutional controls (ICs) would be required to prohibit digging in containment areas and exposing the contaminated soils.
Overall Protection of Human Health and the Environment Rating:	**+**

Table C.2B
Evaluation Summary for Compliance with ARARs – Alternative 2

Evaluation Factors for Compliance with ARARs	Evaluation Summary
Compliance with Chemical-Specific Applicable or Relevant and Appropriate Requirement (ARARs)	• Removal of mining wastes and contaminated materials and placing them under a soil cover would physically address contaminant sources, thus meeting chemical-specific ARARs. • Chemical-specific ARARs for the remedy would be addressed during implementation.
Compliance with Location-Specific ARARs	• Location-specific ARARs for the remedy would be addressed during implementation.
Compliance with Action-Specific ARARs	• The majority of action-specific ARARs are requirements for proper disposal of excavated soils, which would be addressed during implementation.
Compliance with ARARs Rating:	**+**

Table C.2C
Evaluation Summary for Long-Term Effectiveness and Permanence – Alternative 2

Evaluation Factors for Long-Term Effectiveness and Permanence	Evaluation Summary
Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities Adequacy and reliability of controls that are used to manage treatment residuals and untreated waste remaining at the site	• Long-term effectiveness and permanence for parcels containing mine waste and metals-contaminated soil is addressed through excavation of soil, and backfilling of excavated areas with clean soil. • This alternative significantly reduces the risk of being exposed to contaminated materials, but long-term effectiveness is not entirely ensured because contaminated waste in on-site consolidation areas potentially poses a risk. • O&M activities, including inspection, maintenance, and repair will be required to maintain the integrity of the cap. These O&M activities are usually easy to implement; however, the number of small consolidation and capped areas may hinder the ease at which these activities are implemented. • Long-term effectiveness of ICs for on-site consolidation areas is not ensured, particularly on privately owned parcels. • Monitoring and periodic risk evaluation updates would be performed to ensure the long-term effectiveness and permanence of the remedy.
Long-Term Effectiveness and Permanence Rating:	❸

Table C.2D
Evaluation Summary for Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 2

Evaluation Factors for Reduction of Toxicity, Mobility, or Volume through Treatment	Evaluation Summary
The treatment process, the alternative uses, and materials they will treat The degree of expected reduction in toxicity, mobility, or volume of contamination due to treatment The type and quantity of materials that will remain following treatment Whether the alternative would satisfy the statutory preference for treatment as a principal element of the RA.	• This alternative does not treat mining wastes or metals-contaminated soils. However, the mine waste and metals-contaminated soils would be placed in on-site consolidation areas and capped, thereby significantly reducing the mobility of the contamination. The toxicity and volume of contamination would remain unchanged.
Reduction of Toxicity, Mobility, or Volume through Treatment:	❶

Table C.2E
Short-Term Effectiveness Evaluation Summary – Alternative 2

Evaluation Factors for Short-Term Effectiveness	Evaluation Summary
Short-term risks that might be posed to the community during implementation of an alternative	• This alternative would be performed by licensed contractors who would collect and dispose of contaminated materials in properly designed consolidation areas. • Contaminant exposure for construction workers during excavation would be managed using standard health and safety (H&S) procedures and protocols. • Work zones to protect the community would be implemented. • Dust suppression would mitigate any lead-laden dust in excavation areas.
Potential impacts to workers during implementation and the reliability of protective measures taken to minimize these impacts	• Workers would have Occupational Safety and Health Administration Hazardous Waste Operations and Emergency Response (OSHA HAZWOPER) training and would be required to wear appropriate personal protective equipment (PPE). • Work zones to protect workers would be implemented.
Potential adverse environmental impacts resulting from implementation of an alternative and the reliability of the available mitigation measure during implementation	• No adverse impacts to the environment are expected from excavation, transport, or disposal of contaminated soil. • Proper procedures for handling, transporting, and disposing of contaminated soil would prevent any release to the environment.
Short-Term Effectiveness Rating:	❸

Table C.2F
Implementability Evaluation Summary – Alternative 2

Evaluation Factors for Implementability		Evaluation Summary
Technical Feasibility	Technical difficulties and unknowns associated with the construction and operation of a technology	• Implementation of this alternative would include standard excavation equipment, depending on site accessibility. • Backfill, transport and disposal are common, relatively straightforward, and very implementable. • Removal, consolidation, and capping has been successfully implemented at mining sites in other OUs in Cherokee County and is relatively straightforward.
	Reliability of the technology, focusing on technical problems that will lead to schedule delays	• The proposed technologies are reliable and have been readily implemented at other OUs at the Cherokee County Site.
Administrative Feasibility	Coordination issues with other office and agencies during construction or operations of the remedy.	• This alternative would require coordination with residents and property owners to proceed with the RA.
	The ability and time required to obtain necessary approvals and permits from other agencies for off-site actions or discharge scenarios	• Regulatory approval needed for removals and to construct on-site waste consolidation areas may be difficult to obtain given the number of individual areas.
Availability of Goods and Services	Availability of adequate off-site treatment, storage capacity, and disposal capacity and services	• Not applicable as mine wastes and contaminated soils would be disposed of on site.
	Availability of necessary equipment and specialists required to completed construction of remedy components	• A licensed contractor would be needed to perform soil excavation, backfill, and restoration activities. • Large quantities of clean fill would be needed for both backfilling excavations and for constructing the cap on the consolidation areas. There may be difficulty in obtaining an adequate quantity of clean fill.
	Availability of services and materials plus the potential for obtaining competitive bids	
	Availability of prospective technologies	
	Implementability Rating:	❸

Table C.2G
Cost Evaluation Summary – Alternative 2

Evaluation Factors for Costs	Approximate Cost (Dollars)
Total Capital Costs	$14,250,000
Total Annual O&M Costs	$784,000
Total Periodic Cost	$111,000
Total Present Value Cost	$14,965,000

Note: Total costs are for the assumed period of evaluation. Costs are rounded to the nearest $1,000.

Alternative 3
Source Removal, Waste Consolidation, and Capping at OU3/OU4 Consolidation Areas

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Table C.3A
Evaluation Summary for Overall Protection of Human Health and the Environment – Alternative 3

Evaluation Factors for Overall Protection of Human Health and the Environment	Evaluation Summary
Adequate protection of human health and the environment (short- and long- term) from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the Site	• All mining-related wastes with metals concentrations greater than the preliminary cleanup goals will be addressed through excavation and disposal of soils, which will eliminate the exposure pathway. No contaminated materials will remain at the location of the former rail bed. • Excavated contaminated materials will be replaced with clean fill and topsoil, and a vegetative cover (seeding) will be maintained to restore the property and prevent erosion. • Dust suppression would be practiced during excavation to mitigate soil recontamination and off-site migration of lead-contaminated dust.
Overall Protection of Human Health and the Environment Rating:	**+**

Table C.3B
Evaluation Summary for Compliance with ARARs – Alternative 3

Evaluation Factors for Compliance with ARARs	Evaluation Summary
Compliance with Chemical-Specific ARARs	• Removal of mining wastes and contaminated materials would physically address contaminant sources, thus meeting chemical-specific ARARs. • Chemical-specific ARARs for the remedy would be addressed during implementation.
Compliance with Location-Specific ARARs	• Location-specific ARARs for the remedy would be addressed during implementation.
Compliance with Action-Specific ARARs	• The majority of action-specific ARARs are requirements for proper disposal of excavated soils, which would be addressed during implementation.
Compliance with ARARs Rating:	**+**

Table C.3C
Evaluation Summary for Long-Term Effectiveness and Permanence – Alternative 3

Evaluation Factors for Long-Term Effectiveness and Permanence	Evaluation Summary
Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities Adequacy and reliability of controls that are used to manage treatment residuals and untreated waste remaining at the site	• Long-term effectiveness and permanence for parcels containing mine waste and metals-contaminated soil is addressed through excavation of soil, and backfilling of excavated areas with clean soil. • This alternative significantly reduces the risk of exposure because contaminated waste is disposed of in capped consolidation areas associated with OUs 3 and 4. • O&M will be periodically required to inspect and maintain the consolidation areas. • Monitoring and periodic risk evaluation updates would be performed to ensure the long-term effectiveness and permanence of the remedy.
Long-Term Effectiveness and Permanence Rating:	❹

Table C.3D
Evaluation Summary for Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 3

Evaluation Factors for Reduction of Toxicity, Mobility, or Volume through Treatment	Evaluation Summary
The treatment process, the alternative uses, and materials they will treat The degree of expected reduction in toxicity, mobility, or volume of contamination due to treatment The type and quantity of materials that will remain following treatment Whether the alternative would satisfy the statutory preference for treatment as a principal element of the RA.	• This alternative does not treat mining wastes or metals-contaminated soils. However, the mine waste and metals-contaminated soils would be placed in an OU3/ OU4 consolidation area and capped, thereby significantly reducing the mobility of the contamination, however, the toxicity of the contamination would remain unchanged. Contamination on site would be removed.
Reduction of Toxicity, Mobility, or Volume through Treatment:	❶

Table C.3E
Short-Term Effectiveness Evaluation Summary – Alternative 3

Evaluation Factors for Short-Term Effectiveness	Evaluation Summary
Short-term risks that might be posed to the community during implementation of an alternative	• This alternative would be performed by licensed contractors who would excavate and dispose of contaminated soils in proper disposal areas. • Higher short-term risks are involved because of the high traffic on public roads during transport of contaminated materials to off-site consolidation areas. • Work zones to protect the community would be implemented. • Dust suppression would mitigate any lead-laden dust in excavation areas.
Potential impacts to workers during implementation and the reliability of protective measures taken to minimize these impacts	• Contaminant exposure for construction workers during excavation would be managed using standard H&S procedures and protocols. • All workers would be OSHA trained and would be required to wear appropriate PPE. • Work zones to protect workers would be implemented.
Potential adverse environmental impacts resulting from implementation of an alternative and the reliability of the available mitigation measure during implementation	• No adverse impacts to the environment are expected from excavation, transport, or disposal of contaminated soil. • Proper procedures for handling, transporting, and disposing of contaminated soil would prevent any release to the environment.
Short-Term Effectiveness Rating:	❷

Table C.3F
Implementability Evaluation Summary – Alternative 3

Evaluation Factors for Implementability		Evaluation Summary
Technical Feasibility	Technical difficulties and unknowns associated with the construction and operation of a technology	• Implementation of this alternative would include standard excavation equipment, depending on site accessibility. • Backfill, transport and disposal are common, relatively straightforward and very implementable.
	Reliability of the technology, focusing on technical problems that will lead to schedule delays	• The proposed technologies are reliable and have been readily implemented at other OUs at the Cherokee County Site.
Administrative Feasibility	Coordination issues with other office and agencies during construction or operations of the remedy.	• This alternative would require coordination with residents and property owners to proceed with the RA. • Coordination with RA activities at OUs 3 and 4 will be required for disposal at consolidation areas concurrently under construction.
	The ability and time required to obtain necessary approvals and permits from other agencies for off-site actions or discharge scenarios	
Availability of Goods and Services	Availability of adequate off-site treatment, storage capacity, and disposal capacity and services	• Coordination with RA activities at OUs 3 and 4 will be required for disposal at consolidation areas concurrently under construction.
	Availability of necessary equipment and specialists required to completed construction of remedy components	• A licensed contractor would be needed to perform soil excavation, backfill, and restoration activities. • Large quantities of clean fill would be needed for backfilling excavations. There may be difficulty in obtaining adequate capacity of clean fill.
	Availability of services and materials plus the potential for obtaining competitive bids	
	Availability of prospective technologies	
Implementability Rating:		❹

Table C.3G
Cost Evaluation Summary – Alternative 3

Evaluation Factors for Costs	Approximate Cost (Dollars)
Total Capital Costs	$15,832,000
Total Annual O&M Costs	$224,000
Total Periodic Cost	$21,000
Total Present Value Cost	$16,028,000

Note: Total costs are for the assumed period of evaluation. Costs are rounded to the nearest $1,000.

Alternative 4
On-Site Capping

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Table C.4A
Evaluation Summary for Overall Protection of Human Health and the Environment – Alternative 4

Evaluation Factors for Overall Protection of Human Health and the Environment	Evaluation Summary
Adequate protection of human health and the environment (short- and long- term) from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the Site	• All mining-related wastes with metals concentrations greater than the preliminary cleanup goals would be capped with an 18-inch soil barrier consisting of 12 inches of clayey soil topped with 6 inches of topsoil to eliminate the exposure pathway. • O&M will be required to maintain the integrity of the cap so that it remains protective of human health and the environment. • Institutional controls (ICs) would be required to prohibit disturbance of the containment areas which would expose the contaminated soils. • Monitoring in the form of Five Year Reviews would be performed to ensure the protectiveness of the remedy.
Overall Protection of Human Health and the Environment Rating:	**+**

Table C.4B
Evaluation Summary for Compliance with ARARs – Alternative 4

Evaluation Factors for Compliance with ARARs	Evaluation Summary
Compliance with Chemical-Specific ARARs	• Capping of mining wastes and contaminated materials and placing them under a soil cover would physically address contaminant sources, thus meeting chemical-specific ARARs • Chemical-specific ARARs for the remedy would be addressed during implementation.
Compliance with Location-Specific ARARs	• Location-specific ARARs for the remedy would be addressed during implementation.
Compliance with Action-Specific ARARs	• The majority of action-specific ARARs are requirements for proper disposal of excavated soils, which would be addressed during implementation.
Compliance with ARARs Rating:	**+**

Table C.4C
Evaluation Summary for Long-Term Effectiveness and Permanence – Alternative 4

Evaluation Factors for Long-Term Effectiveness and Permanence	Evaluation Summary
Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities Adequacy and reliability of controls that are used to manage treatment residuals and untreated waste remaining at the site	• Long-term effectiveness and permanence for parcels containing mine waste and metals-contaminated soil is addressed through capping of the contaminated materials in place. • This alternative significantly reduces the risk of exposure, but long-term effectiveness is not entirely ensured because contaminated waste in on-site consolidation areas potentially poses a risk. • Operation and maintenance (O&M) activities will be periodically required to repair the on-site consolidation areas. • Long-term effectiveness of ICs for on-site consolidation areas is not ensured, particularly on privately owned parcels. • Monitoring and periodic risk evaluation updates would be performed to ensure the long-term effectiveness and permanence of the remedy.
Long-Term Effectiveness and Permanence Rating:	❸

Table C.4D
Evaluation Summary for Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 4

Evaluation Factors for Reduction of Toxicity, Mobility, or Volume through Treatment	Evaluation Summary
The treatment process, the alternative uses, and materials they will treat The degree of expected reduction in toxicity, mobility, or volume of contamination due to treatment The type and quantity of materials that will remain following treatment Whether the alternative would satisfy the statutory preference for treatment as a principal element of the RA.	• This alternative does not treat mining wastes or metals-contaminated soils. However, the mine waste and metals-contaminated soils would be capped in place, thereby significantly reducing the mobility of the contamination. The toxicity and volume of contamination would remain unchanged.
Reduction of Toxicity, Mobility, or Volume through Treatment:	❶

Table C.4E
Short-Term Effectiveness Evaluation Summary – Alternative 4

Evaluation Factors for Short-Term Effectiveness	Evaluation Summary
Short-term risks that might be posed to the community during implementation of an alternative	• This alternative would be performed by licensed contractors who would construct the cover. • Work zones to protect the community would be implemented. • Dust suppression would be used to prevent migration of contaminated dust in excavation areas.
Potential impacts to workers during implementation and the reliability of protective measures taken to minimize these impacts	• Contaminant exposure for construction workers during construction would be managed using standard H&S procedures and protocols. • All workers would be OSHA trained and would be required to wear appropriate PPE. • Work zones to protect workers would be implemented.
Potential adverse environmental impacts resulting from implementation of an alternative and the reliability of the available mitigation measure during implementation	• No adverse impacts to the environment are expected from excavation, transport, or disposal of contaminated soil. • Proper procedures for handling, transporting, and disposing of contaminated soil would prevent any release to the environment.
Short-Term Effectiveness Rating:	❸

Table C.4F
Implementability Evaluation Summary – Alternative 4

Evaluation Factors for Implementability		Evaluation Summary
Technical Feasibility	Technical difficulties and unknowns associated with the construction and operation of a technology	• Implementation of this alternative would include standard earthmoving equipment, depending on site accessibility. • Capping in place is very implementable. • The proposed technologies have been readily implemented at other OUs at the Cherokee County Site.
	Reliability of the technology, focusing on technical problems that will lead to schedule delays	• The proposed technologies are reliable and have been readily implemented at other OUs at the Cherokee County Site.
Administrative Feasibility	Coordination issues with other office and agencies during construction or operations of the remedy.	• This alternative would require coordination with residents and property owners to proceed with the RA.
	The ability and time required to obtain necessary approvals and permits from other agencies for off-site actions or discharge scenarios	• Regulatory approval needed for construction of the cap may be difficult to obtain given the number of individual capped areas.
Availability of Goods and Services	Availability of adequate off-site treatment, storage capacity, and disposal capacity and services	• Not applicable as mine wastes and contaminated soils would be capped in place.
	Availability of necessary equipment and specialists required to completed construction of remedy components	• A licensed contractor would be needed to perform cap construction and restoration activities. • Large quantities of clean fill would be needed to construct the cover. There may be difficulty in obtaining adequate volume of clean fill.
	Availability of services and materials plus the potential for obtaining competitive bids	
	Availability of prospective technologies	
	Implementability Rating:	❸

Table C.4G
Cost Evaluation Summary – Alternative 4

Evaluation Factors for Costs	Approximate Cost (Dollars)
Total Capital Costs	$9,071,000
Total Annual O&M Costs	$1,593,000
Total Periodic Cost	$133,000
Total Present Value Cost	$10,550,000

Note: Total costs are for the assumed period of evaluation. Costs are rounded to the nearest $1,000.

APPENDIX D

VOLUME ESTIMATIONS

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Methodology and Assumptions Used for Calculating Estimated Volumes

Estimated volumes were calculated using the information contained in the Remedial Investigation Report (HGL, 2016). This information is shown in the following volume calculation worksheets.

Overall Assumptions for Estimating the Volume of Materials Requiring Remediation

1. All chat comprising the former rail bed would be removed.
2. Backfilling will be required to bring the excavation back to natural grade and provide positive drainage. This includes, at a minimum, six inches of topsoil.
3. Depth of contamination was determined by the following cleanup levels:
   Zinc = 4,000 mg/kg Lead = 1,770 mg/kg
4. ~~Based on a minimal aerial survey, the portions of the former rail beds that have been or will be remediated under other OUs was assumed to be minimal.~~
4. If a height of 0 was given for the rail bed at the test pit location, the total depth of the contamination found in the test was used to calculate the volume.
5. If no width or height dimensions were given for the rail bed at the test pit location, the depth of contamination found in the test pit and the average width of the former rail bed for that segment were used to calculate volume.
6. If there are no test pits along a rail bed segment, the overall average width and average depth of contamination were used to calculate volume.
7. The overall length of abandoned rail line in Cherokee County is 58.44 miles. Based on an aerial survey conducted by EPA, the portions of the former rail lines addressed by other OUs is estimated to be 11.42 miles or 19.54% of the total length. The portions of the former rail line that are no longer present or have been addressed by other means is 7.87 miles or 13.47%of the total length.
8. The volume calucations are based on the total length of each line segment, and so therefore the total length of 58.44 miles. Volumes calculated will be reduced by 33% to account for the rail lines not included in OU8.

Assumptions for Estimating the Volume of Materials Required for Cap Construction

1. For Alternative 2, it was assumed that there would be approximately 58 small consolidation areas on the former rail bed with a footprint of 60 feet x 950 feet.
2. For Alternative 4, the average overall width of the former rail bed (17.9 feet) and a length of 39.15 miles was used to approximate the volume of material needed.
3. Cap will be 12 inches of select fill covered with 6 inches of top soil.

Estimated Volume of Materials Requiring Remediation
Cherokee County Site OU8 Railroads, Cherokee County, Kansas

Alternatives 2 & 3

Segment #	Length (ft)	Average Width (ft)	Adjusted Average Thickness (ft)	Excavation		Top Soil Backfill		Select Fill (Non-top Soil Backfill)	
				Volume (ft^3)	Volume (cy)	Volume (ft^3)	Volume (cy)	Volume (ft^3)	Volume (cy)
A	87,658	20.0	2.6	4,558,216	168,823	876,580	32,466	1,192,149	44,154
B	29,601	19.2	3.2	1,818,685	67,359	284,170	10,525	44,402	1,645
C	37,723	17.9	1.9	1,282,959	47,517	337,621	12,504	929,872	34,440
D	45,248	17.9	1.6	1,295,903	47,996	404,970	14,999	911,747	33,768
E	10,082	17.9	2.4	433,123	16,042	90,234	3,342	343,292	12,715
F	12,364	17.9	2.2	486,894	18,033	110,658	4,098	376,484	13,944
G	23,327	17.8	2.2	913,485	33,833	207,610	7,689	345,240	12,787
H	7,934	21.5	2.0	341,162	12,636	85,291	3,159	131,308	4,863
I	18,960	13.8	2.6	680,285	25,196	130,824	4,845	79,632	2,949
J	25,503	10.8	2.6	716,124	26,523	137,716	5,101	349,391	12,940
K	10,174	15.0	3.5	534,135	19,783	76,305	2,826	38,661	1,432
Total for Cherokee County Superfund Site abandoned rail lines	**308,574**				**483,740**		**101,555**		**175,636**
OU8 Total*	**206,745**				**324,106**		**68,042**		**117,676**

Notes:

* OU8 total is the total for the reduced by 33% to account for the portions of the former rail beds not included in OU8.

Volume Calculation Worksheet - Alternatives 2 and 3
Cherokee County Site OU8 Railroads, Cherokee County Railroads

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Thickness of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
A	13a	9	3	3	6	27	4.5
A	13a	12	0	4	48	48	48
A	13b	50	0	2	24	100	100
A	13c	30	0	3	36	90	90
A	13d	18	0	1	12	18	18
A	13e			1	12	20	20
A	14a	25	0	0.5	6	12.5	12.5
A	15a	9	2	2	0	18	4.5
A	15b	9	2	2	6	18	4.5
A	16a			0	0	0.0	0
A	16b			0	0	0.0	0
A	23a			1	12	20.0	20
A	23b			2	24	40.0	40
A	32a	24	5	5	24	120	12
A	32b	18	12	12	24	216	9
A	33a	18	3	3	24	54	9
A	33b	18	3	3	12	54	9
Average		**20**	**2.5**	**2.6**	**15.9**	**50.3**	**23.6**

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Thickness of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
B	24a	12	0	0.5	6	6	6
B	24b	12	0	2.5	30	30	30
B	25a	18	2	2.5	30	45	9
B	25b	20	4	4	42	80	10
B	26a	22	4	4	36	88	11
B	26b	22	4	4	24	88	11
B	27a	23	4	4	12	92	11.5
B	27b	23	4	4	36	92	11.5
B	28a	21	3	3	24	63	10.5
B	28b	24	3	3	24	72	12
B	29a	16	3	3	30	48	8
B	29b	18	3	4	48	72	9
B	30a	19	3	3	24	57	9.5
B	30b	23	3	3	24	69	11.5
B	31a	16	3	3.5	42	56	8
B	31b	18	3	3	36	54	9
Average		**19.2**	**2.9**	**3.2**	**29.25**	**63.3**	**11.1**

Volume Calculation Worksheet - Alternatives 2 and 3
Cherokee County Site OU8 Railroads, Cherokee County Railroads

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Depth of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
C	21a			2	24	35.8	35.8
C	21b			2	24	35.8	35.8
C	21c			2	24	35.8	35.8
C	22a			1.5	18	26.85	26.85
	Average	**17.9**	**2.2**	**1.9**	**22.5**	**33.6**	**33.6**

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Depth of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
D	17a			1.5	18	26.9	26.9
D	17b			2	24	35.8	35.8
D	17c			2	24	35.8	35.8
D	18a			1	12	17.9	17.9
	Average	**17.9**	**2.2**	**1.6**	**19.5**	**29.1**	**29.1**

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Depth of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
F	19a			2.2	0	39.38	39.38
F	20a			2.2	0	39.38	39.38
F	20b			2.2	0	39.38	39.38
	Average	**17.9**	**2.2**	**2.2**	**0.0**	**39.4**	**39.4**

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Depth of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
G	12a	36	0	1.5	18	54	54
G	12b	14	0	2	24	28	28
G	9a	10	0	1.5	18	15	15
G	9b	14	2	3	36	42	14
G	9c	15	3	3	36	45	7.5
	Average	**17.8**	**1.0**	**2.2**	**26.4**	**36.8**	**23.7**

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Depth of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
H	10a	14	2	2	12	28	7

Volume Calculation Worksheet - Alternatives 2 and 3
Cherokee County Site OU8 Railroads, Cherokee County Railroads

H	10b	14	2	2	12	28	7
H	10c	14	2	2	12	28	7
H	11a	44	0	2	24	88	88
	Average	**21.5**	**1.5**	**2.0**	**15.0**	**43.0**	**27.3**

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Depth of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
I	1a	12	2	2	24	24	6
I	1b	13	2	2.5	30	32.5	6.5
I	1c	16	2	2.5	30	40	8
I	8a	14	2	4	48	56	28
I	8b	14	2	2	24	28	7
	Average	**13.8**	**2.0**	**2.6**	**31.2**	**36.1**	**11.1**

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Depth of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
J	2a			2	24	21.6	21.6
J	3a	10	0	1.5	18	16.2	16.2
J	3b	10	0	1	12	10.8	10.8
J	4a	12	0	3	36	32.4	32.4
J	5a	8	0	2.5	30	27	27
J	5b	14	7	7	36	75.6	7
J	6a			1.5	18	16.2	16.2
J	6b			2	24	21.6	21.6
	Average	**10.8**	**1.4**	**2.6**	**24.8**	**27.7**	**19.1**

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Depth of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
K	7a	15	3	3	36	45	7.5
K	7b	15	3	4	48	60	15
	Average	**15.0**	**3.0**	**3.5**	**42.0**	**52.5**	**11.3**

Volume Calculation Worksheet - Alternatives 2 and 3
Cherokee County Site OU8 Railroads, Cherokee County Railroads

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Depth of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
H	10a	14	2	3	12	42	14
H	10b	14	2	3	12	42	14
H	10c	14	2	3	12	42	14
H	11a	44	0	2	24	88	88
	Average	**21.5**	**1.5**	**2.8**	**15.0**	**53.5**	**32.5**

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Depth of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
I	1a	12	2	3	30	36	12
I	1b	13	2	3	30	39	13
I	1c	16	2	3	30	48	16
I	8a	14	2	3	48	42	14
I	8b	14	2	3	36	42	14
	Average	**13.8**	**2.0**	**3.0**	**34.8**	**41.4**	**13.8**

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Depth of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
J	2a			2	24	21.6	21.6
J	3a	10	0	2	24	21.6	21.6
J	3b	10	0	2	24	21.6	21.6
J	4a	12	0	3	36	32.4	32.4
J	5a	8	0	3.5	42	37.8	37.8
J	5b	14	7	8	36	86.4	14
J	6a			3.5	42	37.8	37.8
J	6b			2	24	21.6	21.6
	Average	**10.8**	**1.4**	**3.3**	**31.5**	**35.1**	**26.1**

Railroad Segment ID	Test Pit #	Width (ft)	Height (ft)	Adjusted Height (ft)	Depth of Contamination (inches)	Cross-Sectional Area for Excavation (ft^2)	Cross-Sectional Area for Backfill (ft^2)
K	7a	15	3	4	42	60	15
K	7b	15	3	4	48	60	15
	Average	**15.0**	**3.0**	**4.0**	**45.0**	**60.0**	**15.0**

APPENDIX E

REMEDIAL ALTERNATIVE COST CALCULATIONS AND DATA

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COST SUMMARY TABLES

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Table E.1
Cost Summary, All Alternatives
Cherokee County Superfund Site OU8
Cherokee County, Kansas

Alternative	Description	Duration, years	Total Present Value of Capital Costs	Total Present Value of O&M Costs	Total Present Value of Periodic Costs	Total Present Value of Alternative
1	No Action	n/a	$0	$0	$103,324	$103,324
2	Source Removal with On-Site Consolidation and Capping	30	$ 14,250,426	$ 627,533	$ 86,627	$ 14,964,586
3	Source Removal with Consolidation and Capping at OU3/OU4 Consolidation Areas	30	$ 15,832,363	$ 179,010	$ 16,697	$ 16,028,070
4	On-Site Capping	30	$ 9,071,027	$ 1,275,238	$ 103,324	$ 10,449,588

Table E.2
Alternative 1 - Present Value Analysis
Cherokee County Superfund Site OU8
Cherokee County, Kansas

Alternative 1 - No Action							
Year	**Annual O&M Costs**	**Present Value of O&M Costs**	**Periodic Costs**	**Present Value of Periodic Costs**	**Capital Costs**	**Present Value of Capital Costs**	**Cumulative Present Value**
0	$0	$0	$0	$0	$0	$0	$0
1	$0	$0	$0	$0	$0	$0	$0
2	$0	$0	$0	$0	$0	$0	$0
3	$0	$0	$0	$0	$0	$0	$0
4	$0	$0	$0	$0	$0	$0	$0
5	$0	$0	$22,167	$20,576	$0	$0	$20,576
6	$0	$0	$0	$0	$0	$0	$0
7	$0	$0	$0	$0	$0	$0	$0
8	$0	$0	$0	$0	$0	$0	$0
9	$0	$0	$0	$0	$0	$0	$0
10	$0	$0	$22,167	$19,100	$0	$0	$19,100
11	$0	$0	$0	$0	$0	$0	$0
12	$0	$0	$0	$0	$0	$0	$0
13	$0	$0	$0	$0	$0	$0	$0
14	$0	$0	$0	$0	$0	$0	$0
15	$0	$0	$22,167	$17,730	$0	$0	$17,730
16	$0	$0	$0	$0	$0	$0	$0
17	$0	$0	$0	$0	$0	$0	$0
18	$0	$0	$0	$0	$0	$0	$0
19	$0	$0	$0	$0	$0	$0	$0
20	$0	$0	$22,167	$16,458	$0	$0	$16,458
21	$0	$0	$0	$0	$0	$0	$0
22	$0	$0	$0	$0	$0	$0	$0
23	$0	$0	$0	$0	$0	$0	$0
24	$0	$0	$0	$0	$0	$0	$0
25	$0	$0	$22,167	$15,277	$0	$0	$15,277
26	$0	$0	$0	$0	$0	$0	$0
27	$0	$0	$0	$0	$0	$0	$0
28	$0	$0	$0	$0	$0	$0	$0
29	$0	$0	$0	$0	$0	$0	$0
30	$0	$0	$22,167	$14,181	$0	$0	$14,181
TOTAL		**$0**		**$103,324**	**$0**	**$0**	**$103,324**

Table E.3
Alternative 2 - Present Value Analysis
Cherokee County Superfund Site OU8
Cherokee County, Kansas

Alternative 2 - Source Removal with On-Site Consolidation and Capping							
Year	**Annual O&M Costs**	**Present Value of O&M Costs**	**Periodic Costs**	**Present Value of Periodic Costs**	**Capital Costs**	**Present Value of Capital Costs**	**Cumulative Present Value**
0	$0	$0	$0	$0	$14,250,426	$14,250,426	$14,250,426
1	$26,130	$25,744	$0	$0	$0	$0	$25,744
2	$26,130	$25,363	$0	$0	$0	$0	$25,363
3	$26,130	$24,989	$0	$0	$0	$0	$24,989
4	$26,130	$24,619	$0	$0	$0	$0	$24,619
5	$26,130	$24,255	$18,585	$17,251	$0	$0	$41,507
6	$26,130	$23,897	$0	$0	$0	$0	$23,897
7	$26,130	$23,544	$0	$0	$0	$0	$23,544
8	$26,130	$23,196	$0	$0	$0	$0	$23,196
9	$26,130	$22,853	$0	$0	$0	$0	$22,853
10	$26,130	$22,515	$18,585	$16,014	$0	$0	$38,529
11	$26,130	$22,183	$0	$0	$0	$0	$22,183
12	$26,130	$21,855	$0	$0	$0	$0	$21,855
13	$26,130	$21,532	$0	$0	$0	$0	$21,532
14	$26,130	$21,214	$0	$0	$0	$0	$21,214
15	$26,130	$20,900	$18,585	$14,865	$0	$0	$35,765
16	$26,130	$20,591	$0	$0	$0	$0	$20,591
17	$26,130	$20,287	$0	$0	$0	$0	$20,287
18	$26,130	$19,987	$0	$0	$0	$0	$19,987
19	$26,130	$19,692	$0	$0	$0	$0	$19,692
20	$26,130	$19,401	$18,585	$13,798	$0	$0	$33,199
21	$26,130	$19,114	$0	$0	$0	$0	$19,114
22	$26,130	$18,832	$0	$0	$0	$0	$18,832
23	$26,130	$18,553	$0	$0	$0	$0	$18,553
24	$26,130	$18,279	$0	$0	$0	$0	$18,279
25	$26,130	$18,009	$18,585	$12,809	$0	$0	$30,817
26	$26,130	$17,743	$0	$0	$0	$0	$17,743
27	$26,130	$17,481	$0	$0	$0	$0	$17,481
28	$26,130	$17,222	$0	$0	$0	$0	$17,222
29	$26,130	$16,968	$0	$0	$0	$0	$16,968
30	$26,130	$16,717	$18,585	$11,890	$0	$0	$28,607
TOTAL		**$627,533**		**$86,627**	**$14,250,426**	**$14,250,426**	**$14,964,586**

Table E.4
Alternative 3 - Present Value Analysis
Cherokee County Superfund Site OU8
Cherokee County, Kansas

Alternative 3 - Source Removal with Consolidation and Capping at OU3/OU4 Consolidation Areas							
Year	**Annual O&M Costs**	**Present Value of O&M Costs**	**Periodic Costs**	**Present Value of Periodic Costs**	**Capital Costs**	**Present Value of Capital Costs**	**Cumulative Present Value**
0	$0	$0	$0	$0	$15,832,363	$15,832,363	$15,832,363
1	$7,454	$7,344	$0	$0	$0	$0	$7,344
2	$7,454	$7,235	$0	$0	$0	$0	$7,235
3	$7,454	$7,128	$0	$0	$0	$0	$7,128
4	$7,454	$7,023	$0	$0	$0	$0	$7,023
5	$7,454	$6,919	$3,582	$3,325	$0	$0	$10,244
6	$7,454	$6,817	$0	$0	$0	$0	$6,817
7	$7,454	$6,716	$0	$0	$0	$0	$6,716
8	$7,454	$6,617	$0	$0	$0	$0	$6,617
9	$7,454	$6,519	$0	$0	$0	$0	$6,519
10	$7,454	$6,423	$3,582	$3,087	$0	$0	$9,509
11	$7,454	$6,328	$0	$0	$0	$0	$6,328
12	$7,454	$6,234	$0	$0	$0	$0	$6,234
13	$7,454	$6,142	$0	$0	$0	$0	$6,142
14	$7,454	$6,051	$0	$0	$0	$0	$6,051
15	$7,454	$5,962	$3,582	$2,865	$0	$0	$8,827
16	$7,454	$5,874	$0	$0	$0	$0	$5,874
17	$7,454	$5,787	$0	$0	$0	$0	$5,787
18	$7,454	$5,702	$0	$0	$0	$0	$5,702
19	$7,454	$5,617	$0	$0	$0	$0	$5,617
20	$7,454	$5,534	$3,582	$2,660	$0	$0	$8,194
21	$7,454	$5,452	$0	$0	$0	$0	$5,452
22	$7,454	$5,372	$0	$0	$0	$0	$5,372
23	$7,454	$5,293	$0	$0	$0	$0	$5,293
24	$7,454	$5,214	$0	$0	$0	$0	$5,214
25	$7,454	$5,137	$3,582	$2,469	$0	$0	$7,606
26	$7,454	$5,061	$0	$0	$0	$0	$5,061
27	$7,454	$4,987	$0	$0	$0	$0	$4,987
28	$7,454	$4,913	$0	$0	$0	$0	$4,913
29	$7,454	$4,840	$0	$0	$0	$0	$4,840
30	$7,454	$4,769	$3,582	$2,292	$0	$0	$7,060
TOTAL		**$179,010**		**$16,697**	**$15,832,363**	**$15,832,363**	**$16,028,070**

Table E.5
Alternative 4 - Present Value Analysis
Cherokee County Superfund Site OU8
Cherokee County, Kansas

Alternative 4 - On-Site Capping							
Year	**Annual O&M Costs**	**Present Value of O&M Costs**	**Periodic Costs**	**Present Value of Periodic Costs**	**Capital Costs**	**Present Value of Capital Costs**	**Cumulative Present Value**
0	$0	$0	$0	$0	$9,071,027	$9,071,027	$9,071,027
1	$53,100	$52,315	$0	$0	$0	$0	$52,315
2	$53,100	$51,542	$0	$0	$0	$0	$51,542
3	$53,100	$50,780	$0	$0	$0	$0	$50,780
4	$53,100	$50,030	$0	$0	$0	$0	$50,030
5	$53,100	$49,291	$22,167	$20,576	$0	$0	$69,867
6	$53,100	$48,562	$0	$0	$0	$0	$48,562
7	$53,100	$47,844	$0	$0	$0	$0	$47,844
8	$53,100	$47,137	$0	$0	$0	$0	$47,137
9	$53,100	$46,441	$0	$0	$0	$0	$46,441
10	$53,100	$45,754	$22,167	$19,100	$0	$0	$64,855
11	$53,100	$45,078	$0	$0	$0	$0	$45,078
12	$53,100	$44,412	$0	$0	$0	$0	$44,412
13	$53,100	$43,756	$0	$0	$0	$0	$43,756
14	$53,100	$43,109	$0	$0	$0	$0	$43,109
15	$53,100	$42,472	$22,167	$17,730	$0	$0	$60,202
16	$53,100	$41,844	$0	$0	$0	$0	$41,844
17	$53,100	$41,226	$0	$0	$0	$0	$41,226
18	$53,100	$40,617	$0	$0	$0	$0	$40,617
19	$53,100	$40,016	$0	$0	$0	$0	$40,016
20	$53,100	$39,425	$22,167	$16,458	$0	$0	$55,883
21	$53,100	$38,842	$0	$0	$0	$0	$38,842
22	$53,100	$38,268	$0	$0	$0	$0	$38,268
23	$53,100	$37,703	$0	$0	$0	$0	$37,703
24	$53,100	$37,146	$0	$0	$0	$0	$37,146
25	$53,100	$36,597	$22,167	$15,277	$0	$0	$51,874
26	$53,100	$36,056	$0	$0	$0	$0	$36,056
27	$53,100	$35,523	$0	$0	$0	$0	$35,523
28	$53,100	$34,998	$0	$0	$0	$0	$34,998
29	$53,100	$34,481	$0	$0	$0	$0	$34,481
30	$53,100	$33,971	$22,167	$14,181	$0	$0	$48,153
TOTAL		**$1,275,238**		**$103,324**	**$9,071,027**	**$9,071,027**	**$10,449,588**

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **Capital Costs for Alternative 2**

Unit costs are based on the most recent costing efforts for RA at Cherokee County OUs 3 and 4 unless noted below.

Item	Description	Estimated Quantity	Unit of Measure	Unit Cost	Project Cost	Notes
01 - Initial Activities					**$205,855**	
01	Prepare Work Plans & Permits/Mobilization	1		$40,000.00	$40,000	
02	Temporary Fencing	2,000	LF	$4.07	$8,140	Resued as needed for higher traffic areas.
03	Temporary Access/Haul Road Improvements	64	LS	$1,500	$96,000	
04	XRF Grid Survey	12,343	EA	$5.00	$61,715	Covers technician and XRF rental; assume 20 shots/hour. To determine lateral extent.
02 - Site Preparation					**$203,445**	
05	Construction Survey and Staking	2	DY	$1,104	$2,207	
	Temporary Erosion and Sediment Control - Pre-Construction					
06	Stabilized Construction Entrance	2	EA	$1,500	$3,000	
07	Silt Fence	10,000	LF	$1.42	$14,200	Resused and moved with construction area
08	Straw Bales	5,800	EA	$5.00	$29,000	Assume 100 bales/mile to address minor drainages and road ditches
09	Clearing and Grubbing	180.0	AC	$835.01	$150,302	Assumed 25' work area along line would need clearing and grubbing
	Demolition					
10	Barbed Wire Fence Demolition	3,200	LF	$1.48	$4,736	Assumed at least two per access area @ 25' width, no fences running along former rail bed
03 - Earthwork					**$2,075,262**	
	Mine Waste and Contaminated Soil					
11	Excavation, Hauling, and Placement - On Site Consolidation	265,800	BCY	$7.39	$1,964,262	Assume "on site" means waste is consolidated within 1 mile of its excavation point; and 18% of material remains in place within consolidation areas
12	Excavation, Hauling, and Placement - Consolidation Area <10 miles		BCY	$8.41	$0	
13	Excavation, Hauling, and Placement -Consolidation Area 10 to 30 miles		BCY	$15.23	$0	
14	XRF Confirmation Sampling	18,500	EA	$6.00	$111,000	Assume on a 50' spacing along centerlineand on each side of rail bed
04 - Restoration					**$6,509,949**	
	Import and Place Soil from Off-Site Borrow Sources					
	General Restoration					
15	Select Fill	96,500	ECY	$21.65	$2,089,225	Estimated volume needed to bring the excavations back flush with the ground surface. Assume 18%
16	Top Soil	55,800	ECY	$30.28	$1,689,624	reduction in material quantities for consolidation areas constructed in-place over the former rail bed.
	Mine Waste Consolidation Area					
17	Select Fill	54,200	ECY	$20.30	$1,100,260	Assume 58 small consolidation areas over rail bed footprint at 60' X 420' w/ max height of 10'. Cap of 12
18	Top Soil	28,000	ECY	$29.75	$833,000	inches select fill and 6 inches of top soil.
19	Finish Grading	147	AC	$1,123	$165,259	
20	Mine Waste Consolidation Area Boundary Monuments	348	EA	$158.89	$55,294	
	Seed/Fertilizer/Mulch					
21	Seed - Pasture	147	AC	$2,233	$328,690	
22	Seed - Native		AC	$2,814	$0	
23	Seed - Wetland		AC	$2,987	$0	
	Drainage Improvements					
24	Drainage Swale/Replace Roadway Ditch	4,135	LF	$17.36	$71,782	Assume 2% of project length requires ditch repairs or new drainage.
25	Replace/Repair Access Gate	16	EA	$607.45	$9,719	Assume one quarter of the temporary access points require gate replacement.
26	Replace/Repair Barbed Wire Fence	3,840	LF	$4.07	$15,629	Demo length plus 20%.
27	Remove/Repair Temporary Access/Haul Road	13	LS	$1,500	$19,200	Assume 20% of the access points require removal or repair.
	Temporary Erosion and Sediment Control - Post-Construction					
28	Silt Fence	10,000	LF	$1.42	$14,200	
29	Straw Bales	5,800	LF	$13.46	$78,068	
30	Straw Wattles		LF	$1.71	$0	
31	Inspection and Maintenance	1	LS	$40,000.00	$40,000	Walking inspection of all disturbed areas plus miscellaneous topsoil repair and seeding.
				SubTotal:	**$8,994,511**	
32	Bid and Scope Contingency	35%	percent		**$3,148,078.84**	Scope contingency of 25% and Bid contingency of 10%
33	Project Management	5%	percent		**$607,129.49**	Based on EPA guidance.
34	Remedial Design	6%	percent		**$728,555.39**	Based on EPA guidance.
35	Construction Management	6%	percent		**$728,555.39**	Based on EPA guidance.
				Estimated Construction Total:	**$14,206,830**	

Notes:
AC: Acre; BCY: Bank Cubic Yard; DY: Day; EA: Each; ECY: Embankment Cubic Yard; LF: Linear Feet; LS: Lump Sum; SY: Square Yard

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **Annual O&M for Alternative 2**

Unit costs are based on the most recent costing efforts for RA at Cherokee County OUs 3 and 4 unless noted below.

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
Cover Maintenance						
01	**Repair Eroded Areas**					
02	Excavation, Hauling, and Placement	700	ECY	$20.30	$14,210.00	
03	Revegetate Cover	1	acre	$2,233.18	$2,233.18	
04	Staff Engineer - annual inspection of LUCs	32	per hour	$109.48	$3,503.35	RACER 33220106
				Subtotal:	$19,946.53	
05	Bid and Scope contingency	20%	percent		$3,989.31	Bid and Scope contingency of 10% each.
06	Project Management	5%	percent		$997.33	Based on EPA Guidance.
07	Technical Support	6%	percent		$1,196.79	Based on EPA Guidance.
				Total O&M Cost	**$26,129.95**	

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **Periodic Costs for Alternative 2**

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
5 Year Review, Reporting						
01	Staff Engineer	60	per hour	$109.48	$6,568.84	RACER 33220106
02	Project Engineer	20	per hour	$139.21	$2,784.26	RACER 33220105
03	Draftsman/CADD	32	per hour	$87.39	$2,796.61	RACER 33220115
04	Project Manager	12	per hour	$169.75	$2,036.97	RACER 33220102
				Subtotal:	$14,186.68	
05	Bid and Scope contingency	20%	percent		$2,837.34	Bid and Scope contingency of 10% each.
06	Project Management	5%	percent		$709.33	Based on EPA Guidance.
07	Technical Support	6%	percent		$851.20	Based on EPA Guidance.
				Total Periodic Costs	**$18,584.55**	

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **LUCs for Alternative 2**

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
Implementation of LUCs						
01	3-man survey crew	8	day	$1,103.60	$8,828.80	
02	Staff Engineer	120	per hour	$109.48	$10,864.87	RACER 33220106
03	Project Engineer	40	per hour	$139.21	$4,605.17	RACER 33220105
04	Draftsman/CADD	64	per hour	$87.39	$4,625.59	RACER 33220115
05	Project Manager	24	per hour	$169.75	$3,369.15	RACER 33220102
				Subtotal:	$32,293.57	
06	Bid and Scope contingency	35%	percent		$11,302.75	Scope Contingency of 25%. Bid Contingency of 10%
				Total Cost	**$43,596.32**	

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **Capital Costs for Alternative 3**

Unit costs are based on the most recent costing efforts for RA at Cherokee County OUs 3 and 4 unless noted below.

Item	Description	Estimated Quantity	Unit of Measure	Unit Cost	Project Cost	Notes
01 - Initial Activities					**$205,855**	
01	Prepare Work Plans & Permits/Mobilization	1		$40,000.00	$40,000	
02	Temporary Fencing	2,000	LF	$4.07	$8,140	Resued as needed for higher traffic areas.
03	Temporary Access/Haul Road Improvements	64	LS	$1,500	$96,000	
04	XRF Grid Survey	12,343	EA	$5.00	$61,715	Covers technician and XRF rental; assume 20 shots/hour. To determine lateral extent.
02 - Site Preparation					**$203,445**	
05	Construction Survey and Staking	2	DY	$1,104	$2,207	
	Temporary Erosion and Sediment Control - Pre-Construction					
06	Stabilized Construction Entrance	2	EA	$1,500	$3,000	
07	Silt Fence	10,000	LF	$1.42	$14,200	
08	Straw Bales	5,800	EA	$5.00	$29,000	Assume 100 bales/mile to address minor drainages and road ditches
09	Clearing and Grubbing	180.0	AC	$835.01	$150,302	Assumed 25' work area along line would need clearing and grubbing
	Demolition					
10	Barbed Wire Fence Demolition	3,200	LF	$1.48	$4,736	Assumed at least two per access area @ 25' width, no fences running along former rail bed
04 - Earthwork					**$4,274,496**	
	Mine Waste and Contaminated Soil					
11	Excavation, Hauling, and Placement - On Site Consolidation		BCY	$7.39	$0	
12	Excavation, Hauling, and Placement - Consolidation Area <10 miles	113,500	BCY	$8.41	$954,535	Assumed 35% of total volume and dozer work at consolidation area. R.S. Mean - 2 CY Excavotor, 18 CY Haul Truck, D10 Bulldozer.
13	Excavation, Hauling, and Placement -Consolidation Area 10 to 30 miles	210,700	BCY	$15.23	$3,208,961	Assumed 65% of total volume and dozer work at consolidation area. R.S. Mean - 2 CY Excavotor, 18 CY Haul Truck, D10 Bulldozer.
14	XRF Confirmation Sampling	18,500	EA	$6.00	$111,000	Assume on a 50' spacing along centerlineand on each side of rail bed
05 - Restoration					**$5,334,440**	
	Import and Place Soil from Off-Site Borrow Sources					
	General Restoration					
15	Select Fill	117,676	ECY	$21.65	$2,547,688	Estimated volume needed to bring the excavations back flush with the ground surface.
16	Top Soil	68,042	ECY	$30.28	$2,060,307	
	Mine Waste Consolidation Area					
17	Select Fill		ECY	$20.30	$0	Assume the OU3 or OU4 consolidation areas can receive the OU8 material at no cost to the OU8 project.
18	Top Soil		ECY	$29.75	$0	
19	Finish Grading	142	AC	$1,123	$159,872	
20	Mine Waste Consolidation Area Boundary Monuments		EA	$158.89	$0	
	Seed/Fertilizer/Mulch					
21	Seed - Pasture	142	AC	$2,233	$317,975	
22	Seed - Native		AC	$2,814	$0	
23	Seed - Wetland		AC	$2,987	$0	
	Drainage Improvements					
24	Drainage Swale/Replace Roadway Ditch	4,135	LF	$17.36	$71,782	Assume 2% of project length requires ditch repairs or new drainage
25	Replace/Repair Access Gate	16	EA	$607.45	$9,719	Assume one quarter of the temporary access points require gate replacement
26	Replace/Repair Barbed Wire Fence	3,840	LF	$4.07	$15,629	Demo length plus 20%
27	Remove/Repair Temporary Access/Haul Road	13	LS	$1,500	$19,200	Assume 20% of the access points require removal or repair
	Temporary Erosion and Sediment Control - Post-Construction					
28	Silt Fence	10,000	LF	$1.42	$14,200	
29	Straw Bales	5,800	LF	$13.46	$78,068	
30	Straw Wattles		LF	$1.71	$0	
31	Inspection and Maintenance	1	LS	$40,000.00	$40,000	Walking inspection of all disturbed areas plus miscellaneous topsoil repair and seeding
				SubTotal:	**$10,018,236**	
32	Bid and Scope Contingency	35%	percent		**$3,506,382.44**	Scope contingency of 25% and Bid contingency of 10%
33	Project Management	5%	percent		**$676,230.90**	Based on EPA guidance.
34	Remedial Design	6%	percent		**$811,477.08**	Based on EPA guidance.
35	Construction Management	6%	percent		**$811,477.08**	Based on EPA guidance.
				Estimated Construction Total:	**$15,823,803**	

Notes:
AC: Acre; BCY: Bank Cubic Yard; DY: Day; EA: Each; ECY: Embankment Cubic Yard; LF: Linear Feet; LS: Lump Sum; SY: Square Yard

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **Annual O&M for Alternative 3**

Unit costs are based on the most recent costing efforts for RA at Cherokee County OUs 3 and 4 unless noted below.

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
Cover Maintenance						
01	**Repair Eroded Areas**					
02	Excavation, Hauling, and Placement	140	ECY	$20.30	$2,842.00	
03	Revegetate Cover	1	acre	$2,233.18	$2,233.18	
04	Staff Engineer - annual inspection of LUCs	8	per hour	$109.48	$875.84	RACER 33220106
				Subtotal:	$5,951.02	
05	Bid and Scope contingency	20%	percent		$1,190.20	Bid and Scope contingency of 10% each.
06	Project Management	5%	percent		$142.10	Based on EPA Guidance.
07	Technical Support	6%	percent		$170.52	Based on EPA Guidance.
				Total O&M Cost	**$7,453.84**	

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **Periodic Costs for Alternative 3**

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
5 Year Review, Reporting						
01	Staff Engineer	12	per hour	$109.48	$1,313.77	RACER 33220106
02	Project Engineer	4	per hour	$139.21	$556.85	RACER 33220105
03	Draftsman/CADD	6	per hour	$87.39	$524.36	RACER 33220115
04	Project Manager	2	per hour	$169.75	$339.50	RACER 33220102
				Subtotal:	$2,734.48	
05	Bid and Scope contingency	20%	percent		$546.90	Bid and Scope contingency of 10% each.
06	Project Management	5%	percent		$136.72	Based on EPA Guidance.
07	Technical Support	6%	percent		$164.07	Based on EPA Guidance.
				Total Periodic Costs	**$3,582.17**	

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **LUCs for Alternative 3**

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
Implementation of LUCs						
01	3-man survey crew	2	per hour	$208.38	$448.73	
02	Staff Engineer	24	per hour	$115.99	$2,719.73	RACER 33220106
03	Project Engineer	8	per hour	$147.49	$1,152.78	RACER 33220105
04	Draftsman/CADD	13	per hour	$92.59	$1,175.99	RACER 33220115
05	Project Manager	4.8	per hour	$179.84	$843.38	RACER 33220102
					$6,340.60	
06	Contingency	35%	percent		$2,219.21	Scope Contingency of 25%. Bid Contingency of 10%
				Total Cost	**$8,559.82**	

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **Capital Costs for Alternative 4**

Unit costs are based on the most recent costing efforts for RA at Cherokee County OUs 3 and 4 unless noted below.

Item	Description	Estimated Quantity	Unit of Measure	Unit Cost	Project Cost	Notes
01 - Initial Activities					**$205,855**	
01	Prepare Work Plans & Permits/Mobilization	1		$40,000.00	$40,000	
02	Temporary Fencing	2,000	LF	$4.07	$8,140	Resued as needed for higher traffic areas.
03	Temporary Access/Haul Road Improvements	64	LS	$1,500	$96,000	Rough count of 58, assume I missed 10%
04	XRF Grid Survey	12,343	EA	$5.00	$61,715	Covers technician and XRF rental; assume 20 shots/hour. To determine lateral extent.
02 - Site Preparation					**$203,445**	
05	Construction Survey and Staking	2	DY	$1,104	$2,207	
	Temporary Erosion and Sediment Control - Pre-Construction					
06	Stabilized Construction Entrance	2	EA	$1,500	$3,000	
07	Silt Fence	10,000	LF	$1.42	$14,200	Resused and moved with construction area
08	Straw Bales	5,800	EA	$5.00	$29,000	Assume 100 bales/mile to address minor drainages and road ditches
09	Clearing and Grubbing	180.0	AC	$835.01	$150,302	Assumed 25' work area along line would need clearing and grubbing
	Demolition					
10	Barbed Wire Fence Demolition	3,200	LF	$1.48	$4,736	Assumed at least two per access area @ 25' width, no fences running along former rail bed
04 - Earthwork					**$0**	
	Mine Waste and Contaminated Soil					
11	Excavation, Hauling, and Placement - On Site Consolidation		BCY	$7.39	$0	
12	Excavation, Hauling, and Placement - Consolidation Area <10 miles		BCY	$5.80	$0	
13	Excavation, Hauling, and Placement -Consolidation Area 10 to 30 miles		BCY	$12.57	$0	R.S. Means 2102, Excavator w/ CY Bucket,
14	XRF Confirmation Sampling		EA	$6.00	$0	Assume on a 50' spacing along centerlineand on each side of rail bed
05 - Restoration					**$5,303,128**	
	Import and Place Soil from Off-Site Borrow Sources					
	General Restoration					
15	Select Fill		ECY	$21.65	$0	
16	Top Soil		ECY	$30.28	$0	
	Mine Waste Consolidation Area					
17	Select Fill	142,000	ECY	$20.30	$2,882,600	
18	Top Soil	69,000	ECY	$29.75	$2,052,750	
19	Finish Grading	19	AC	$1,123	$21,374	
20	Mine Waste Consolidation Area Boundary Monuments	348	EA	$158.89	$55,294	
	Seed/Fertilizer/Mulch					
21	Seed - Pasture	19	AC	$2,233	$42,512	
22	Seed - Native		AC	$2,814	$0	
23	Seed - Wetland		AC	$2,987	$0	
	Drainage Improvements					
24	Drainage Swale/Replace Roadway Ditch	4,135	LF	$17.36	$71,782	Assume 2% of project length requires ditch repairs or new drainage
25	Replace/Repair Access Gate	16	EA	$607.45	$9,719	Assume one quarter of the temporary access points require gate replacement
26	Replace/Repair Barbed Wire Fence	3,840	LF	$4.07	$15,629	Demo length plus 20%
27	Remove/Repair Temporary Access/Haul Road	13	LS	$1,500	$19,200	Assume 20% of the access points require removal or repair
	Temporary Erosion and Sediment Control - Post-Construction					
28	Silt Fence	10,000	LF	$1.42	$14,200	
29	Straw Bales	5,800	LF	$13.46	$78,068	
30	Straw Wattles		LF	$1.71	$0	
31	Inspection and Maintenance	1	LS	$40,000.00	$40,000	Walking inspection of all disturbed areas plus miscellaneous topsoil repair and seeding
				SubTotal:	**$5,712,428**	
32	Bid and Scope Contingency	35%	percent		**$1,999,349.88**	Scope contingency of 25% and Bid contingency of 10%
33	Project Management	5%	percent		**$385,588.91**	Based on EPA guidance.
34	Remedial Design	6%	percent		**$462,706.69**	Based on EPA guidance.
35	Construction Management	6%	percent		**$462,706.69**	Based on EPA guidance.
				Estimated Construction Total:	**$9,022,780**	

Notes:
AC: Acre; BCY: Bank Cubic Yard; DY: Day; EA: Each; ECY: Embankment Cubic Yard; LF: Linear Feet; LS: Lump Sum; SY: Square Yard

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **Annual O&M for Alternative 4**

Unit costs are based on the most recent costing efforts for RA at Cherokee County OUs 3 and 4 unless noted below.

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
Cover Maintenance						
01	**Repair Eroded Areas**					
02	Excavation, Hauling, and Placement	1400	BCY	$20.30	$28,420.00	
03	Revegetate Cover	2	acre	$2,233.18	$4,466.36	
04	Staff Engineer - annual inspection of LUCs	80	per hour	$109.48	$8,758.37	RACER 33220106
				Subtotal:	$41,644.73	
05	Bid and Scope contingency	20%	percent		$8,328.95	Bid and Scope contingency of 10% each.
06	Project Management	5%	percent		$1,421.00	Based on EPA Guidance.
07	Technical Support	6%	percent		$1,705.20	Based on EPA Guidance.
				Total O&M Cost	**$53,099.87**	

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **Periodic Costs for Alternative 4**

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
5 Year Review, Reporting						
01	Staff Engineer	72	per hour	$109.48	$7,882.61	RACER 33220106
02	Project Engineer	24	per hour	$139.21	$3,341.11	RACER 33220105
03	Draftsman/CADD	38	per hour	$87.39	$3,320.97	RACER 33220115
04	Project Manager	14	per hour	$169.75	$2,376.47	RACER 33220102
				Subtotal:	$16,921.16	
05	Bid and Scope contingency	20%	percent		$3,384.23	Bid and Scope contingency of 10% each
06	Project Management	5%	percent		$846.06	Based on EPA Guidance.
07	Technical Support	6%	percent		$1,015.27	Based on EPA Guidance.
				Total O&M Cost	**$22,166.72**	

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **LUCs for Alternative 4**

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
Implementation of LUCs						
	DESCRIPTION	**QTY**	**UNIT**	**UNIT COST**	**TOTAL**	**NOTES**
01	3-man survey crew	8	day	$1,103.60	$8,828.80	
02	Staff Engineer	120	per hour	$125.55	$12,459.71	RACER 33220106
03	Project Engineer	40	per hour	$159.65	$5,281.15	RACER 33220105
04	Draftsman/CADD	64	per hour	$100.22	$5,304.57	RACER 33220115
05	Project Manager	24	per hour	$194.66	$3,863.70	RACER 33220102
					$35,737.94	
06	Contingency	35%	percent		$12,508.28	Scope Contingency of 25%. Bid Contingency of 10%
				Total Cost	**$48,246.22**	

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **LUCs for Alternative 3**

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
Implementation of LUCs						
01	3-man survey crew	2	per hour	$208.38	$448.73	
02	Staff Engineer	24	per hour	$115.99	$2,719.73	RACER 33220106
03	Project Engineer	8	per hour	$147.49	$1,152.78	RACER 33220105
04	Draftsman/CADD	13	per hour	$92.59	$1,175.99	RACER 33220115
05	Project Manager	4.8	per hour	$179.84	$843.38	RACER 33220102
					$6,340.60	
06	Contingency	35%	percent		$2,219.21	Scope Contingency of 25%. Bid Contingency of 10%
				Total Cost	**$8,559.82**	

ALTERNATIVE 4 COST WORKSHEETS

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Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **Capital Costs for Alternative 4**

Unit costs are based on the most recent costing efforts for RA at Cherokee County OUs 3 and 4 unless noted below.

Item	Description	Estimated Quantity	Unit of Measure	Unit Cost	Project Cost	Notes
01 - Initial Activities					**$205,855**	
01	Prepare Work Plans & Permits/Mobilization	1		$40,000.00	$40,000	
02	Temporary Fencing	2,000	LF	$4.07	$8,140	Resued as needed for higher traffic areas.
03	Temporary Access/Haul Road Improvements	64	LS	$1,500	$96,000	Rough count of 58, assume I missed 10%
04	XRF Grid Survey	12,343	EA	$5.00	$61,715	Covers technician and XRF rental; assume 20 shots/hour. To determine lateral extent.
02 - Site Preparation					**$203,445**	
05	Construction Survey and Staking	2	DY	$1,104	$2,207	
	Temporary Erosion and Sediment Control - Pre-Construction					
06	Stabilized Construction Entrance	2	EA	$1,500	$3,000	
07	Silt Fence	10,000	LF	$1.42	$14,200	Resused and moved with construction area
08	Straw Bales	5,800	EA	$5.00	$29,000	Assume 100 bales/mile to address minor drainages and road ditches
09	Clearing and Grubbing	180.0	AC	$835.01	$150,302	Assumed 25' work area along line would need clearing and grubbing
	Demolition					
10	Barbed Wire Fence Demolition	3,200	LF	$1.48	$4,736	Assumed at least two per access area @ 25' width, no fences running along former rail bed
04 - Earthwork					**$0**	
	Mine Waste and Contaminated Soil					
11	Excavation, Hauling, and Placement - On Site Consolidation		BCY	$7.39	$0	Assume "on site" means waste is consolidated within 1 mile of its excavation point; 60,000 CY of material remains in place within consolidation areas
12	Excavation, Hauling, and Placement - On/Off Site Consolidation (<10 miles)		BCY	$5.80	$0	
13	Excavation, Hauling, and Placement - Off Site Consolidation (10 to 30 miles)		BCY	$12.57	$0	R.S. Means 2102, Excavator w/ CY Bucket,
14	XRF Confirmation Sampling		EA	$6.00	$0	Assume on a 50' spacing along centerlineand on each side of rail bed
05 - Restoration					**$8,294,302**	
	Import and Place Soil from Off-Site Borrow Sources					
	General Restoration					
15	Select Fill		ECY	$21.65	$0	Estimated volume needed to bring the excavations back flush with the ground surface. Assume 20% reduction in material quantities for consolidation areas constructed in-place over the rail line
16	Top Soil		ECY	$30.28	$0	
	Mine Waste Consolidation Area					
17	Select Fill	205,000	ECY	$20.30	$4,161,500	
18	Top Soil	103,000	ECY	$29.75	$3,064,250	
19	Finish Grading	217.3	AC	$1,123	$244,002	
20	Mine Waste Consolidation Area Boundary Monuments	348	EA	$158.89	$55,294	
	Seed/Fertilizer/Mulch					
21	Seed - Pasture	217.3	AC	$2,233	$485,304	
22	Seed - Native		AC	$2,814	$0	
23	Seed - Wetland		AC	$2,987	$0	
	Drainage Improvements					
24	Drainage Swale/Replace Roadway Ditch	6,172	LF	$17.36	$107,137	Assume 2% of project length requires ditch repairs or new drainage
25	Replace/Repair Access Gate	16	EA	$607.45	$9,719	Assume one quarter of the temporary access points require gate replacement
26	Replace/Repair Barbed Wire Fence	3,840	LF	$4.07	$15,629	Demo length plus 20%
27	Remove/Repair Temporary Access/Haul Road	13	LS	$1,500	$19,200	Assume 20% of the access points require removal or repair
	Temporary Erosion and Sediment Control - Post-Construction					
28	Silt Fence	10,000	LF	$1.42	$14,200	
29	Straw Bales	5,800	LF	$13.46	$78,068	
30	Straw Wattles		LF	$1.71	$0	
31	Inspection and Maintenance	1	LS	$40,000.00	$40,000	Walking inspection of all disturbed areas plus miscellaneous topsoil repair and seeding
				SubTotal:	**$8,703,602**	
32	Bid and Scope Contingency	35%	percent		**$3,046,260.85**	Scope contingency of 25% and Bid contingency of 10%
33	Project Management	5%	percent		**$587,493.16**	Based on EPA guidance.
34	Remedial Design	6%	percent		**$704,991.80**	Based on EPA guidance.
35	Construction Management	6%	percent		**$704,991.80**	Based on EPA guidance.
				Estimated Construction Total:	**$13,747,340**	

Notes:
AC: Acre; BCY: Bank Cubic Yard; DY: Day; EA: Each; ECY: Embankment Cubic Yard; LF: Linear Feet; LS: Lump Sum; SY: Square Yard

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **Annual O&M for Alternative 4**

Unit costs are based on the most recent costing efforts for RA at Cherokee County OUs 3 and 4 unless noted below.

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
Cover Maintenance						
01	**Repair Eroded Areas**					
02	Excavation, Hauling, and Placement	1400	BCY	$20.30	$28,420.00	
03	Revegetate Cover	2	acre	$2,233.18	$4,466.36	
04	Staff Engineer - annual inspection of LUCs	80	per hour	$109.48	$8,758.37	RACER 33220106
				Subtotal:	$41,644.73	
05	Bid and Scope contingency	20%	percent		$8,328.95	Bid and Scope contingency of 10% each.
06	Project Management	5%	percent		$1,421.00	Based on EPA Guidance.
07	Technical Support	6%	percent		$1,705.20	Based on EPA Guidance.
				Total O&M Cost	**$53,099.87**	

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **Periodic Costs for Alternative 4**

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
5 Year Review, Reporting						
01	Staff Engineer	72	per hour	$109.48	$7,882.61	RACER 33220106
02	Project Engineer	24	per hour	$139.21	$3,341.11	RACER 33220105
03	Draftsman/CADD	38	per hour	$87.39	$3,320.97	RACER 33220115
04	Project Manager	14	per hour	$169.75	$2,376.47	RACER 33220102
				Subtotal:	$16,921.16	
05	Bid and Scope contingency	20%	percent		$3,384.23	Bid and Scope contingency of 10% each
06	Project Management	5%	percent		$846.06	Based on EPA Guidance.
07	Technical Support	6%	percent		$1,015.27	Based on EPA Guidance.
				Total O&M Cost	**$22,166.72**	

Site: Cherokee County Superfund Site OU8
Location: Cherokee County, Kansas
Phase: Feasibility Study
Base Year: 2016
Date: 5/6/2016

Description: **LUCs for Alternative 4**

Item	Description	Estimated Quantity	Unit of Measure	Unit cost	Project Cost	Notes
Implementation of LUCs						
	DESCRIPTION	**QTY**	**UNIT**	**UNIT COST**	**TOTAL**	**NOTES**
01	3-man survey crew	8	day	$1,103.60	$8,828.80	
02	Staff Engineer	120	per hour	$125.55	$12,459.71	RACER 33220106
03	Project Engineer	40	per hour	$159.65	$5,281.15	RACER 33220105
04	Draftsman/CADD	64	per hour	$100.22	$5,304.57	RACER 33220115
05	Project Manager	24	per hour	$194.66	$3,863.70	RACER 33220102
					$35,737.94	
06	Contingency	35%	percent		$12,508.28	Scope Contingency of 25%. Bid Contingency of 10%
				Total Cost	**$48,246.22**	